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Eng

# GEODÆSIA:

OR, THE

# ART OF SURVEYING

AND

## MEASURING LAND MADE EASY.

SHEWING

By plain and practical RULES, to Survey, Protract, Caſt up, Reduce or Divide any Piece of Land whatſoever; with new TABLES for the Eaſe of the Surveyor in Reducing the Meaſure of Land.

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---

BY JOHN LOVE.

---

THE ELEVENTH EDITION,

CORRECTED AND IMPROVED.

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# THE PREFACE TO THE READER.

IT would be ridiculous, to go about to praiſe an art that all mankind know they cannot live peaceably without, and is near hand as ancient (no doubt on it) as the world: for how could men ſet down to plant, without knowing ſome diſtinction and bounds of their land? But (neceſſity being the mother of invention) we find the Egyptians, by reaſon of the Nile's overflowing, which either waſhed away all their bound-marks, or covered them over with

mud, brought this meaſuring of land firſt into an art, and honoured much the profeſſors of it. The uſefulneſs, as well as the pleaſant and delightful ſtudy, and wholeſome exerciſe thereof, tempted ſo many to apply themſelves thereto, that at length in Egypt (as in Bermudas) every ruſtic could meaſure his own land.

From Egypt, this art was brought into Greece by Thales, and was for a long time called Geometry; but that being too comprehenſive a name for the menſuration of a ſuperficies only, it was afterwards called Geodæſia; and what honour it ſtill has continued to have among the antients, needs no better proof than Plato's ἀγεωμέτρητος ὐδεὶς εἰσίετο. And not only Plato, but moſt, if not all the learned men of thoſe times, refuſed to admit any into their ſchools, that had not been firſt entered in the mathematics, eſpecially geometry and arithmetic. And we may ſee, the great monuments of learning built on theſe foundations continuing unſhaken to this day, ſufficiently demonſtrate the wiſdom of the deſigners in chooſing geometry for their ground-plot.

Since

Since which, the Romans have had ſuch an opinion of this ſort of learning, that they concluded that man to be incapable of commanding a legion, that did not poſſeſs at leaſt ſo much geometry, as to know how to meaſure a field. Nor did they indeed either reſpect prieſt or phyſician, that had not ſome inſight into the mathematics.

Nor can we complain of any failure of reſpect given to this excellent ſcience by our modern worthies, many noblemen, clergymen, and gentlemen affecting the ſtudy thereof: ſo that we may ſafely ſay, none but unadviſed men ever did, or do now ſpeak evil of it.

Beſides the many profits this art brings to man, it is a ſtudy ſo pleaſant, and affords ſuch wholeſome and innocent exerciſe, that we ſeldom find a man that has once entered himſelf into the ſtudy of Geometry or Geodæſia, can ever after wholly lay it aſide: ſo natural is it to the minds of men, ſo pleaſingly inſinuating, that the Pythagoreans thought the mathe-

matics to be only a reminiſcience, or calling again to mind things formerly learned.

But no longer to light candles to ſee the ſun by, let me come to my buſineſs, which is to ſpeak ſomething concerning the following book; and if you aſk, why I write a book of this nature, ſince we have ſo many very good ones already in our own language? I anſwer, Becauſe I cannot find in thoſe books many things, of great conſequence, to be underſtood by the ſurveyor. I have ſeen young men in America ſo often at a loſs, that their books would not help them forward; (particularly in Carolina,) about laying out lands, when a certain quantity of acres has been given to be laid out five or ſix times as broad as long. This I know is regarded as a mere trifle by a mathematician; yet to ſuch as have no more of this learning, than to know how to meaſure a field, it ſeems a difficult queſtion: and to what book of ſurveying ſhall they repair to be reſolved?

Alſo concerning the Extraction of the Square Root; I wonder that it has been ſo much

much neglected by the teachers of this art, it being a rule of ſuch abſolute neceſſity for the ſurveyor to be acquainted with. I have taught here as plainly as I could deviſe, and that by the beſt method now in uſe, uſing fewer figures, and being once well learned, charges the memory leſs than any other way.

Moreover, ſounding the entrance of a river or harbour is a matter of great import, not only to ſeamen, but to all ſuch as ſeamen live by; I have therefore done my endeavour to teach the young artiſt how to do it, and draw a fair draught thereof.

Many more things have I added, ſuch as I thought to be new, and wanting; for which I refer you to the book itſelf.

As for method, I have choſe that which I thought to be the eaſieſt for a learner; adviſing him firſt to learn ſome arithmetic, and after, teaching him how to extract the ſquare root. But I would not have any neophyte diſcouraged; for if he find the firſt chapter too hard for him, let him rather

ſkip it, and go to the ſecond and third chapters: thoſe he will find ſo eaſy and delightful, that I am perſuaded he will be encouraged to conquer the difficulty of learning that one rule in the firſt chapter.

From Arithmetic, I have proceeded on to teach ſo much Geometry as the art of ſurveying requires. In the next place, I have ſhewed by what meaſures land is ſurveyed, and made ſeveral tables for the reducing one ſort of meaſure into another.

From thence I come to the deſcription of inſtruments, and how to uſe them; wherein I have chiefly inſiſted on the ſemicircle, it being the beſt that I know of.

The ſixth chapter teacheth how to apply all the foregoing matters together, in the practical ſurveying of any field, wood, &c. divers ways, by various inſtruments; and how to lay down the ſame upon paper. Alſo at the end of this chapter I have largely inſiſted on, and by new and eaſy ways, taught ſurveying by the chain only.

The

The ſeventh, eighth, ninth, tenth, and eleventh chapters, teach how to caſt up the contents of any plot of land; to lay out new lands; alſo to ſurvey a manor, county, or country; and, how to reduce and divide lands, &c.

The twelfth chapter conſiſts wholly of Trigonometry.

The thirteenth chapter treats of heights and diſtances, including, amongſt other things, how to make a map of a river or harbour, and to convey water from a ſpring-head to any appointed place, or the like.

Laſtly, at the end of the book, I have added a table of northing or ſouthing, eaſting or weſting; or, (if you pleaſe to call it ſo) a table of difference of latitude and departure from the meridian, with directions for the uſe thereof. Alſo a table of ſines and tangents, and a table of logarithms.

I have followed Mr. Holwell's method, in making the table of ſines and tangents but to every fifth minute, that being near enough

enough in practice for the ſurveyor's uſe; for it is not poſſible with the beſt inſtrument that ever was yet made, to take an angle in the field nigher, if ſo nigh, as to five minutes.

All which I commend to the ingenious reader, wiſhing he may find benefit thereby, and deſiring his favourable reception thereof accordingly. I conclude,

READER,

Your Humble Servant,

J. L.

THE

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# GEODÆSIA:

OR, THE

# ART OF MEASURING LAND, &c.

## CHAP. I.

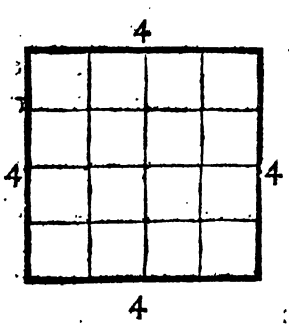
### *Of* ARITHMETIC.

IT is very neceſſary for him that intends to be an artiſt in the Meaſuring of Land, to be well acquainted with arithmetic, as being the ground-work and foundation of all arts and ſciences mathematical; or at leaſt not to be ignorant of the five firſt and principal rules thereof, viz. *Numeration*, *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*: which, ſuppoſing every Perſon that applies himſelf to the ſtudy of this art to be ſkilled in; or if not, referring him to Books or Maſters (every where to be found) to learn: I ſhall name a ſixth rule, as neceſſary (if not more) to be underſtood by the learner; which is the extraction of the

ſquare root; without which (though ſeldom mentioned by ſurveyors in their writings) a man can never attain to a competent knowledge in the art: I ſhall not therefore think it unworthy my pains (though perhaps other men have better done it before me) to ſhew you eaſily and briefly how to do it.

### *To extract the Square Root of any given Number.*

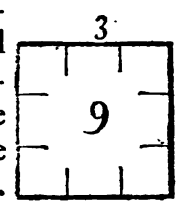
In the firſt place it is convenient to tell you what the ſquare root is: it is to find out of any number propounded a leſs number, which number being multiplied in itſelf, may produce the number propounded. As for example: ſuppoſe 81 be a number given me, I ſay 9 is the root of it; becauſe 9 multiplied in itſelf, *viz.* 9 times 9 is 81. Now 8 could not be the root, for 8 times 8 is but 64: nor could 10, for 10 times ten is 100; therefore, I ſay, 9 muſt needs be the root, becauſe multiplied in itſelf, it makes neither more nor leſs than the number propounded, *viz.* 81.




Again: Suppoſe 16 be the number given, I ſay the root of it is 4, becauſe 4 multiplied in itſelf makes 16. For your better underſtanding ſee this figure, which is a great ſquare, containing 16 little ſquares; any ſide of which great ſquare, contains 4 little ſquares: which is called the ſquare root.

Or,

Or, ſuppoſe a plain ſquare figure be given you, as this in the margin, and it be required of you to divide it into 9 ſmall ſquares; your buſineſs is to know into how many parts to divide any one of the ſide lines, which here muſt be into 3, and that is the root required.




But how to do this readily, is the thing I am now going to teach you. The roots of all ſquare numbers under 100, you have in your multiplication table; however, ſince it is good for you to keep them in your mind, take this ſmall table of them.

| Roots | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Squares | 1 | 4 | 9 | 16 | 25 | 36 | 49 | 64 | 81 |

Here you ſee the root of 25 is 5, the root of 64 is 8, and ſo of the reſt.

So far as 100 in whole numbers, your memory will ſerve you to find the root; but if the number propounded, whoſe root you are to ſearch out, exceed 100, then put a point over the firſt figure on the right hand, which is the place of units, and ſo proceeding to the left hand, miſs the ſecond figure, and put a point over the third; then miſſing the fourth, point the fifth; and ſo (if there be ever ſo many figures in the number) proceed on to the end, pointing every other figure, as you may ſee here, and ſo many points as there are, of ſo many figures your root will conſiſt, which is very material to remember: then begin at the firſt figure on the left hand that has a point over it, which will always be

. . . .
1234567

the firſt or ſecond figure, and ſearch out the root of the one figure, or both joined together if there be two; and when you have found it or the nigheſt leſs to it, which you may eaſily do by the table above, or your own memory, draw a little crooked line, as in diviſion, and there ſet it down; then ſquare that root or quotient, (that is, multiply it by itſelf) and ſet it under the firſt ſquare; draw a line and ſubtract; to this remainder bring down the next period, or pair of figures; double the root, and place it on the left hand for a diviſor, then ſee how often the diviſor can be held in the reſolvend, (excepting the figure to the right hand) and as often as you find it will go, place it in the root, and alſo in the unit's place of the diviſor; multiply the laſt root by the diviſor, and place the product under the reſolvend; continue thus till all the periods or ſquare numbers be brought down, and if any thing remains, add two cyphers, and work as has been taught above; and for every two cyphers thus added, there will be one decimal place in the root.

## EXAMPLE.

To extract the ſquare root of 99856. Point it as before ſhewn, and it will ſtand thus 99856; then ſeek a number whoſe ſquare ſhall be equal to the firſt figure 9, viz. 3, and write it in the root or quotient; then having ſubtracted from 9, 3 by 3, or 9, there will remain 0: to which ſet down the figures as far as the next point, viz. 98, for the following operation:

Then

Then taking no notice of the laſt figure 8, ſay, how many times is the double of 3 or 6 contained in the firſt figure 9? Anſwer, 1. Wherefore having ſet 1 in the root, ſubtract the product of 1 by 61, or 61 from 98, and there will remain 37; to which connect the laſt figures 5 6, and you will have the number 3756, in which the work is next to be carried on; wherefore, alſo neglecting the laſt figure of this, viz. 6, ſay, How often is the double of 31, or 62, contained in 375 (which may be gueſſed at from the initial figures 6 and 37, by taking notice how many times 6 is contained in 37?) Anſwer, 6; and writing 6 in the quotient, ſubtract 6 by 626 or 3756, and there will remain 0; whence it appears that the buſineſs is done, the root coming out 316.

```
99856(316
9
---
098
 61
---
3756
3756
---
 . .
```

Otherwiſe, with the diviſors ſet down, it will ſtand thus:

```
      9̇9̇8̇5̇6̇(316
      9
     ----
  61)098
      61
     ----
 626)3756
     3756
```

Again, if you were to extract the root out of 22178791: Firſt, having pointed it, ſeek a number, whoſe ſquare, (if it cannot be exactly equalled)

shall be the next less square (or nearest) to 22, the figures to the first point, and you will find it to be 4: for 5 by 5, or 25 is greater than 22, and 4 by 4, or 16 is less: wherefore 4 will be the first figure of the root. This, therefore, being writ in the quotient, from 22 take the square 4 by 4, or 16, and to the remainder 6, adjoin the next period of figures 17, and you will have 617; from whose division, by the double of 4, you are to obtain the second figure of the root, viz. 7, as thus: neglecting the last figure 7, say, How many times 8 is contained in 61? Answer, 7; wherefore write 7 in the quotient, and from 617 take the product of 7 into 87, or 609, and there will remain 8; to which join the two next figures 87, and you will have 887; by the division whereof, by the double of 47, or 94, you are to obtain the third figure; in order to which say, How many times is 94 contained in 88? Answer 0; wherefore write 0 in the quotient, and bring down the two last figures 91, and you will have 88791, by whose division by the double of 470, or 940, you are to obtain the last figure; thus I say, How many times 940 in 8879? Answer 9; wherefore write 9 in the quotient, and you will have the root 4709. But, since the product 9 by 9409, or 84681,

```
22178791 (4709,43637, &c.
16
---
617
609
---
 88791
 84681
---
 411000
 376736
---
 3426400
 2825649
---
 60075100
 56513196
---
 3561904oo
 2825661 69
---
 73624231
```

84681, ſubtracted from 88791, leaves 4110, the number 4709 is not the complete root of the number 22178791, but a little leſs.

If then it be required to have the root approach nearer, carry on the operation in decimals, by annexing to the remainder two cyphers in each operation. Thus the remainder 4110, having two cyphers added to it, becomes 411000; the diviſion whereof by the double of 4709, or 9418, you will have the firſt decimal figure 4. Then having writ 4 in the quotient, ſubtract 4 by 94184, or 376736, from 411000, and there will remain 34264. And ſo having added two more cyphers, the work may be carried on at pleaſure, the root at length coming out 4709,43637, &c.

But when the root is carried half way or above, the reſt of the figures may be obtained by diviſion alone; as in this example, if you had a mind to extract the root to nine figures after the five former 4709,4 are found, the four latter may be found, by dividing the remainder, viz. 342640, by the double of 4704,4.

After the ſame manner are roots extracted out of decimal numbers.—Thus, the root of 329,76 is 18,159: and the root of 3,2976 is 1,8159, and the 0,032976 is 0,18159, and ſo on. But the root of 3297,6 is 57,4247; and the root of 32,976 is 5,74247. And thus the root of 9,9856 is 3,16.

There are other ways taught by arithmeticians for finding the ſquare root of any number; but I know no way ſo conciſe as this, and after a little practice, ſo eaſy and ready, or to be wrought with as few figures. To do it indeed by the logarithms, or artificial numbers, is very eaſy and pleaſant; but ſur-

veyors have not always books of logarithms about them, when they have occaſion to extract the ſquare root; however, I will briefly ſhew you how to do it, and give you one example thereof.

When you have any number given whoſe ſquare root you deſire, ſeek for the given number in the table of logarithms under the title numbers; and right againſt it under the title logarithms, you will find the logarithm of the ſaid number, the half of which is the logarithm of the root deſired: which half ſeek for under the title logarithm, and right againſt it under the title number, you will find the root.

## EXAMPLE.

Let 625 be the number whoſe root is deſired. Firſt, I ſeek for it under the title numbers, and right againſt it I find this Log. 2795880, which I divide by 2, or take the half of it 1,397640, as you ſee: and finding that half under the title Log. right againſt it is 25, the root deſired. See the ſame done by the former way with leſs trouble.

625 (25
4

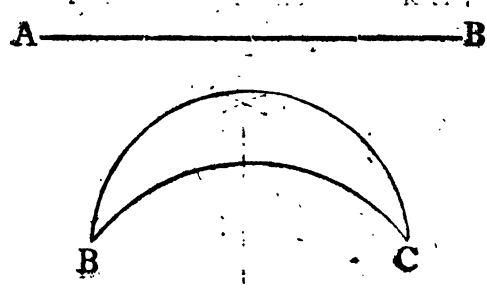
45)225
225

## CHAP. II.

### GEOMETRICAL DEFINITIONS.

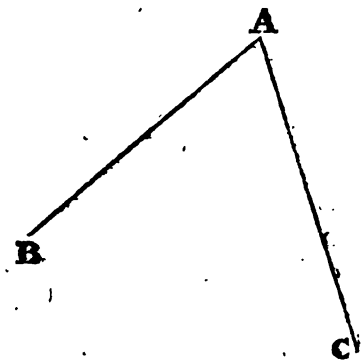
A Point is that which has no parts; conſequently of itſelf no magnitude, and may be conſidered as inviſible. It is commonly marked as a full ſtop in writing, thus (.)

A line has only length, but neither breadth or thickneſs, and may be conceived as generated by the continual motion of a point. There are two ſorts of lines, viz. ſtrait and crooked; as AB is a ſtrait line, BC two crooked lines.



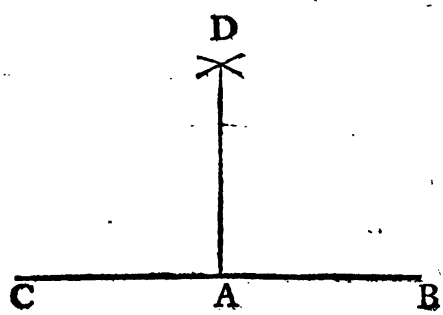

An angle is the meeting of two lines in a point; provided the two lines ſo meeting do not make one ſtrait line, as the line AB, and the line AC, meeting together in the point A, form the angle BAC.

Of




Of right-lined angles there are three ſorts, viz. right-angled, acute, and obtuſe.

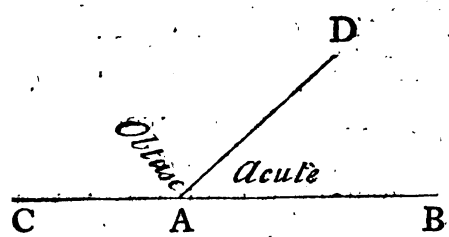
When a line falleth perpendicularly upon another line, it maketh two right angles.



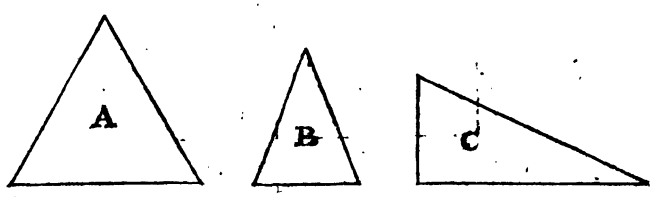

EXAMPLE.

Let CAB be a right line, DA a line perpendicular to it, that is to ſay, neither leaning twowards B nor C, but exactly upright; then are both the angles at A, viz. DAB, and DAC, right angles; and

and contain each juſt 90 degrees, or the fourth part of a circle; but if the line DA had not been perpendicular, but had leaned towards B, then had DAC been an obtuſe angle, or greater than a right angle; and DAB an acute angle, or leſs than a right angle, as you ſee hereunder.




All figures contained under three ſides are called triangles, as A, B, C.




Where note, when a triangle as A hath three equal ſides, it is called an equilateral triangle.

The triangle B hath only two ſides equal, and is therefore called an iſoſceles triangle.

The triangle C hath the three ſides unequal, is called a ſcalene triangle.

*Of*

*Of four-ſided Figures there are theſe Sorts.*

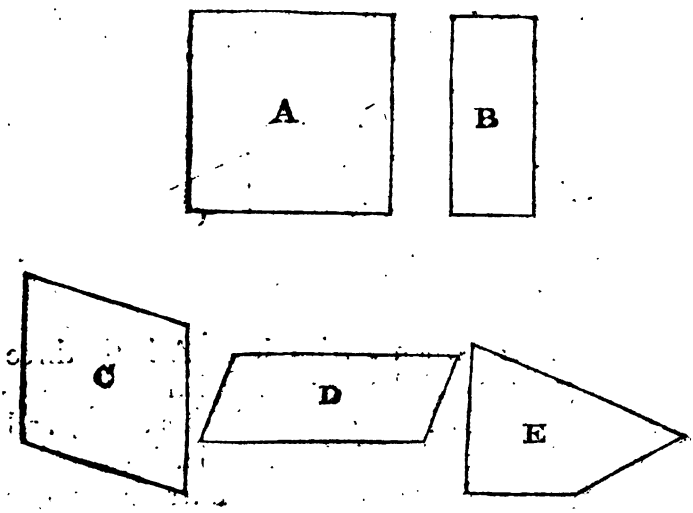
*Firſt*, A ſquare whoſe ſides are all equal, and angles right, as A.

*Secondly*, A long ſquare, or right-angled parallelogram, whoſe oppoſite ſides are equal, and angles right, as B.

*Thirdly*, A rhombus, whoſe ſides are all equal, but no right angle, as C.

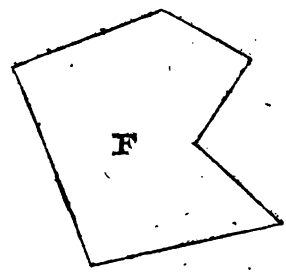
*Fourthly*, A rhomboides, whoſe oppoſite ſides only are equal, and no right angles, as D.

All other four-ſided figures are called trapezia; thus E is a trapezium.



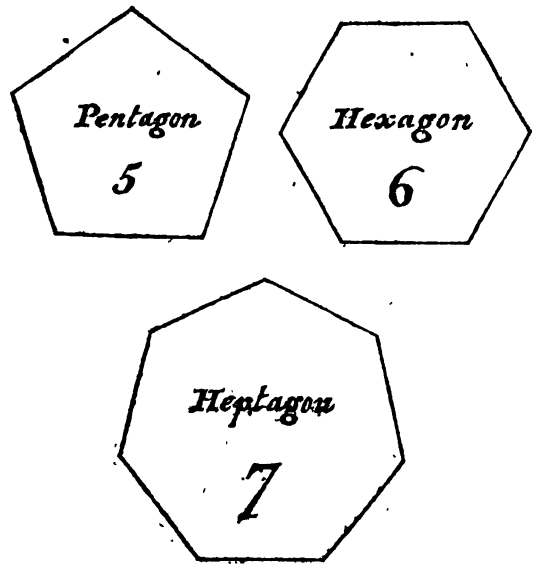

Other

Other figures that are contained under 5, 6, 7, or more ſides, I call irregular, as F, *&c.* except

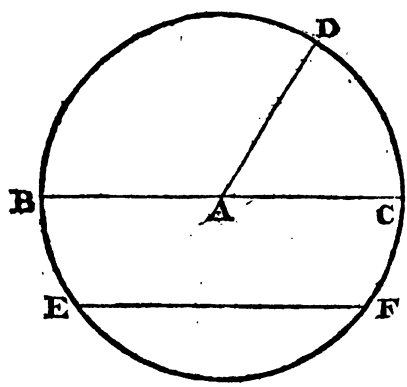



ſuch as are made by dividing the circumference of a circle into any number of equal parts; for then they are regular figures, having all three ſides and angles equal; and are called according to the number of equal parts the circle is divided into, or more properly according to the number of angles they contain, as a pentagon, hexagon, heptagon, octagon, *&c.* Which ſignifies no more than a figure of five, ſix, ſeven, or eight angles; theſe angles are all equal one to another, and their ſides conſequently all of the ſame length. And thus (though I mention no more than eight) the circumference of the circle may be divided into as many equal parts as you pleaſe; and the regular figures formed by ſuch diviſions, are called according to the number of parts the circle is divided into. See, for your better underſtanding, theſe two or three following:

A circle




A circle is a figure bounded by one curved line as A, called the circumference of the circle, in the middle whereof is a point, from whence the circle is deſcribed, and is called the center; from this point or center all ſtrait lines drawn to the circumference are equal, or of the ſame length, as AB, AC, AD.




The

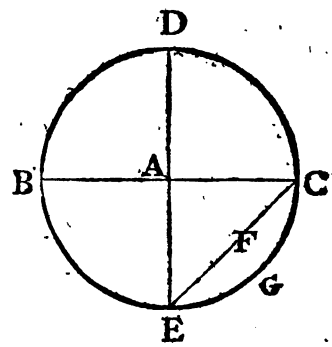
The diameter of a circle is a line as BC, which paſſing through the center, cuts the circle into two equal parts, or it is the longeſt ſtrait line that can be drawn in any circle.

The ſemidiameter, or the radius, is the half of the above-mentioned line, as AB, AC, or AD, either of which is called a ſemidiameter.

A chord is any line ſhorter than the diameter, which paſſeth from one part of the circumference to another, as EC.

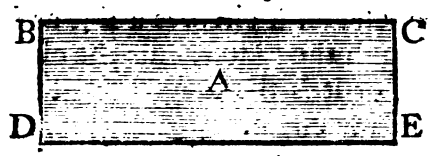
A ſemicircle is the half of a circle, as BDC, or BEC.

A quadrant is the fourth part of a circle, made by two diameters perpendicularly interſecting each other, as ABD, ADC, ABE, AEC, either of which is a quadrant, or the fourth part of a circle.




A ſegment of a circle is a part of the circle cut off by a chord line, and may be either greater or leſs than a ſemicircle. Thus EFCG is the leſſer ſegment, and EBDCF the greater ſegment of the ſame circle EBDCGE.

A ſuperficies is that which hath both length and breadth, but no thickneſs; whoſe bounds are right lines, as A is a ſuperficies or plane, contained by the lines, BC, DE, BD, and CE, whoſe length is BC, and breadth BD.

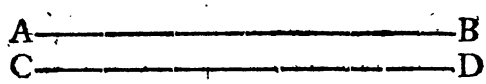



When theſe bounding lines (at right angles to each other) are meaſured, and the content of the ſuperficies caſt up, the reſult is called the area or ſuperficial content of that figure.

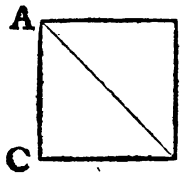
## EXAMPLE.

Suppoſe the line BC to be twelve feet in length, and the line BD to be four feet long, theſe multiplied together produce 48; therefore I ſay, 48 ſquare feet is the area or ſuperficial content of that figure.

When two lines are in every part equidiſtant from each other, they are called parallel lines, as the lines AB and CD;




which though produced to ever ſo great a length, would come no nearer to each other, and conſequently never meet.




A diagonal line is a line running through a ſquare figure, dividing it into two equal triangles, beginning at one angle of the ſquare, and proceeding to the oppoſite angle. In the ſquare ABCD, AD is the diagonal line.

CHAP.

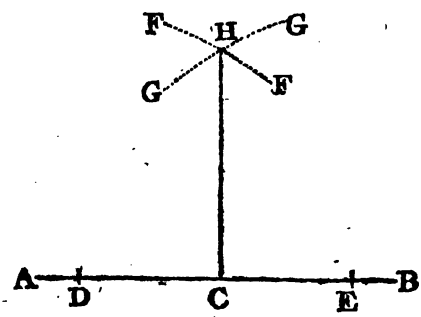
## CHAP. III.

### GEOMETRICAL PROBLEMS.

### PROB. I.

*To draw a line perpendicular to a given line from a point therein aſſigned.*

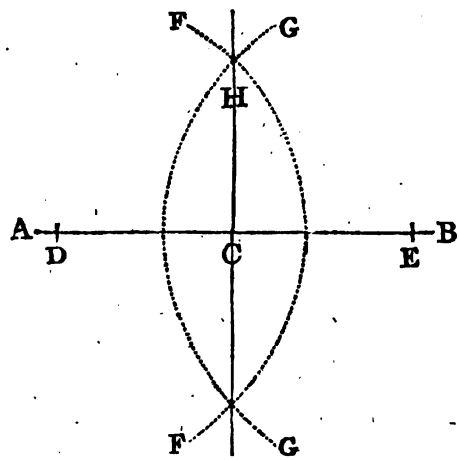
THE line given is AB, and at the point C, it is required to erect a line which ſhall be perpendicular to AB.




Open your compaſſes to any convenient wideneſs, and ſetting one foot of them in the point C, with the other make a mark upon the line at E, and alſo at D; then taking off your compaſſes, open them a little wider than before, and ſetting one foot in the point D, with the other deſcribe the arch FF; then, without altering your compaſſes, ſet one foot in the point E, and with the other deſcribe the arch GG.

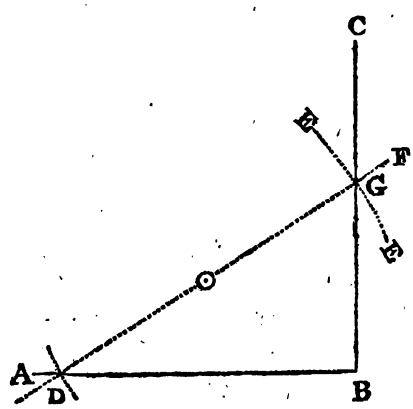
Laſtly, lay your ruler to the point C, and the interſection H of the two arches GG and FF; then draw the line HC, you have your deſire, HC being perpendicular to AB.

See it here done again after the very ſame manner, but perhaps plainer for your underſtanding.




## PROB. II.

*To raiſe a perpendicular upon the end of a line.*

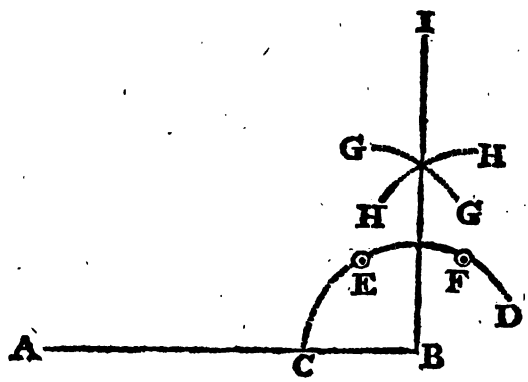


AB is the line given, and at B it is required to erect a perpendicular, as BC.

Open your compaſſes to an ordinary extent, and ſetting one foot in the point B, let the other fall at adventure, no matter where in reaſon, as at the point ⊙; then without altering the extent of the compaſſes, ſet one foot in the point ⊙, and with the other croſs the line AB, as at D: alſo on the other ſide deſcribe the arch EE; then laying your ruler to D and ⊙, draw the dotted line D ⊙ F. Laſtly, from the point B, you began at, through the interſection G, draw the line BGC, which will be perpendicular to AB.

*Another way, I think rather more eaſy, though indeed nearly the ſame.*

Let AB be the given line.

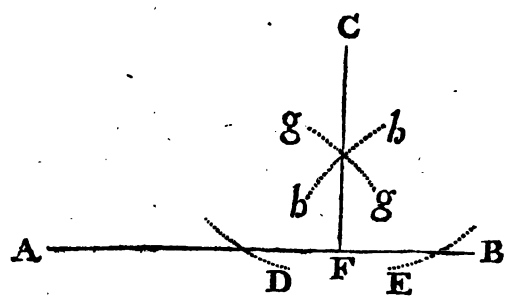


Set one foot of your compaſſes in B, and with the other at any ordinary extent, deſcribe the arch CEFD; then keeping your compaſſes at the ſame extent, ſet one foot in C, and make a mark upon the arch at E; and keeping one foot in E, make another mark at F; then with any extent ſet one foot in E, and with the other deſcribe the arch GG; alſo ſetting one point in F, make the arch HH, then draw a right line, as IB, through the interſection of thoſe arches, and the point firſt propoſed, it will be the perpendicular required.

## PROB. III.

*From a point aſſigned, to let fall a perpendicular upon a line given.*

The line given is AB, the point is at C, from which it is deſired to draw a right line down to AB, that it may be perpendicular to it.

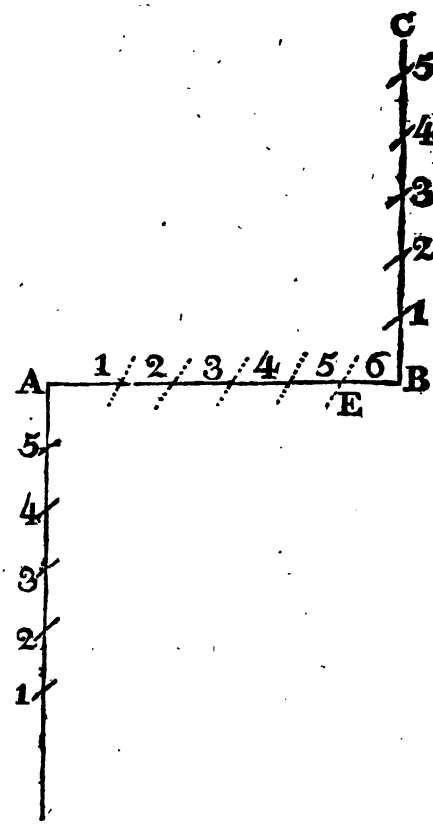



Firſt ſetting one foot of your compaſſes in the point C, with the other make a mark upon the line AB, as at D, and alſo another at E; then opening your compaſſes wider, or ſhutting them cloſer, either will do; ſet one foot in the point

of interſection at D, and with the other deſcribe the arch *g g*; do the like at E, for the arch *h h*. Laſtly, from the point aſſigned, through the point of interſection of the two arches, *g g* and *h h*, draw the perpendicular line CF.

## PROB. IV.

*To divide a line into any number of equal parts.*




AB is a line given, and it is required to divide it into 6 equal parts.

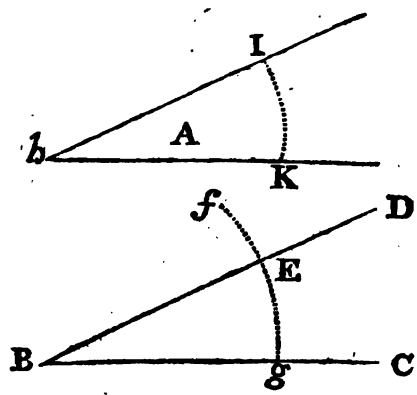
Make at the point B a line perpendicular to AB, as BC: do the ſame at A, the contrary way, as you ſee here; open your compaſſes to any convenient wideneſs, and upon the lines BC and AD, mark out five equal parts; for it muſt be always one leſs than the number you intend to divide the line into: which parts you may number as you

ſee here, thoſe upon one line one way, and the other the contrary way; then laying your ruler from N° 1. on the line BC, to N° 1. on the line AD, it will interſect the line AB at E, which you may mark with your pen, and the diſtance between B and E is one ſixth part of the line; ſo proceed on till you come to N° 5. and then you will find that you have divided the given line into ſix equal parts, as required.

## PROB. V.

*To make an angle equal to any other angle given.*

The angle given is A, and you are deſired to make one equal to it.



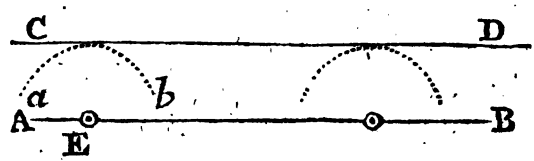

Draw the line BC, then going to the angle A, ſet one foot of your compaſſes in the point *b*, and with the other at what diſtance you pleaſe,

deſcribe the arch IK; then without altering the extent of the compaſſes, ſet one foot in B, and draw the arch *fg*; after that meaſure with your compaſſes how far it is from K to I, and the ſame diſtance ſet down upon the arch from *g* towards *f*, which will fall at E; draw the line BED, and the angle DBC will be equal to the given angle A.

## PROB. VI.

*To draw lines parallel to each other.*

AB is a line given, and it is required to draw a line parallel to it.

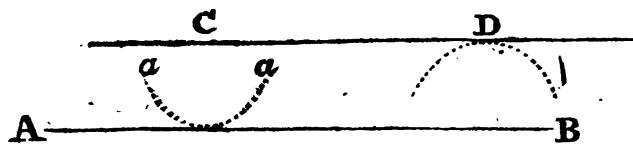



Set one foot of your compaſſes at or near the end of your given line, as at E, and with the other deſcribe the arch *ab*; do the ſame near the other end of the ſaid line; then draw the line CD, juſt to touch the convexity of thoſe arches, and it will be the parallel required.

## PROB. VII.

*To draw a line parallel to another line, which ſhall alſo paſs through a point aſſigned.*

Let AB be the given line, C the point through which the required parallel line muſt paſs.




Set one foot of your compaſſes in C, and cloſing them ſo that they will juſt touch (and no more) the line AB, deſcribe the arch *aa*; with the ſame extent in any part of the given line ſet one foot, and deſcribe another arch, as at D; then through the aſſigned point C, draw a right line CD, juſt to touch the convexity of the laſt deſcribed arch, and it will be parallel to AB, as was required.

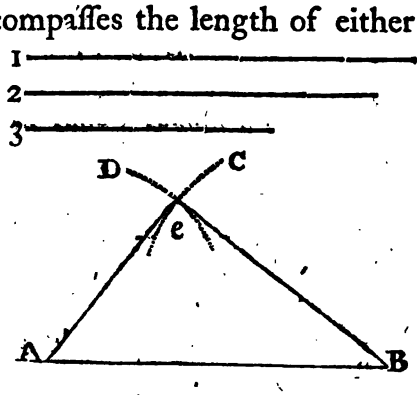
## PROB. VIII.

*To form a triangle with three given right lines, provided any two of theſe lines, taken together, be longer than the third.*

Let the three lines given, be thoſe marked 1, 2, 3, in the next figure.

Take

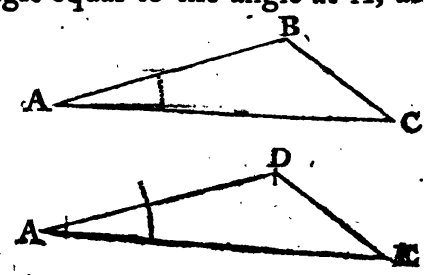
Take with your compaſſes the length of either of the three in this example: let it be that N° 1. *viz.* the longeſt, and lay it down as hereunder from A to B; then taking with your compaſſes the length of the line 2, ſet one foot in B, and make the arch C; alſo taking the length of the laſt line 3, place your compaſſes at A, and deſcribe the arch D, which will interſect the arch C in the point *e*; from this point of interſection draw right lines to the points AB, which ſhall conſtitute the triangle A *e* B; the line AB being equal to the line N° 1, B*e* to N° 2, and A*e* to N° 3.




## PROB. IX.

*To make a triangle equal and equiangular to a triangle given.*

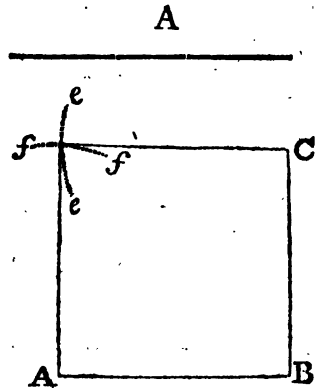
Firſt make an angle equal to the angle at A, as you were taught in *Prob.* 5. Then making the lines AD and AE reſpectively equal to AB and AC, draw the line DE.




PROB.

## PROB. X.

*To deſcribe a ſquare figure upon a given right line.*




Let A be a line given and it is required to make a ſquare figure thereon.

Firſt, Lay down the length of your line A, as AB.

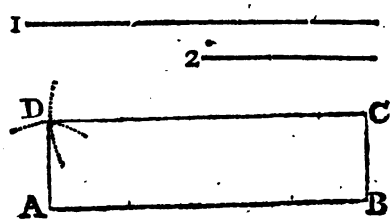
Secondly, Raiſe BC perpendicular and equal to BA.

Thirdly, Take the length of either of the aforementioned lines with your compaſſes, and ſetting one foot in C, deſcribe the arch *ee*; do the like at A, and deſcribe the arch *ff*.

Fourthly, Draw lines from A and C to the point of interſection, and the ſquare is finiſhed.

## PROB. XI.

*To make a right-angled parallelogram, or long ſquare.*




This is much like the former. Admit two lines be given, as 1, 2, and it is required to make a parallelogram of them: what a parallel-

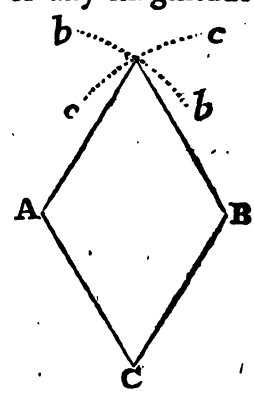
a parallelogram is, you may ſee in the ſecond chapter of *Definitions*.

Firſt, Lay down your longeſt line, as AB, upon the end of B, of which erect a perpendicular line, equal in length to your ſhorteſt line; and ſo proceed, as you were taught in the foregoing problem.

## PROB. XII.

### *To deſcribe a rhombus.*

Firſt, Make an angle, ACB, of any magnitude at pleaſure with two equal lines, as AC and BC; then taking one of theſe lines in your compaſſes, ſet one foot in A, and deſcribe the arch *bb*; alſo ſet one foot in B, and deſcribe the arch *cc*. Laſtly, draw lines from A and B to the point of interſection, and it is finiſhed. The two equilateral triangles together, form a rhombus.



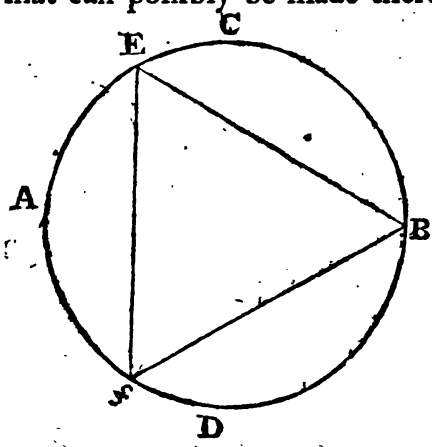

A rhomboides differs from a rhombus, as a right-angled parallelogram does from a ſquare; it being no other than an oblique parallelogram, and therefore it is needleſs to give its deſcription.

PROB.

## PROB. XIII.

*To divide a circle into any number of equal parts, not exceeding ten, and alſo to ſhew how the figures called,* Pentagon, Hexagon, Heptagon, Octagon, &c. *may be deſcribed.*

Let ABCD be a circle, in which it is required to inſcribe an equilateral triangle, being the greateſt that can poſſibly be made therein.

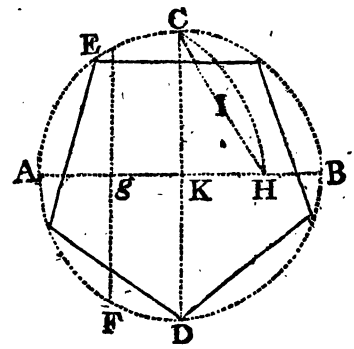



Keeping your compaſſes at the ſame extent they were at when you made the circle, ſet one point of them in any part of the circumference, as at A, and with the other make a mark at E, and alſo at *f*; then draw a line from E to *f*, which will be one ſide of the triangle.

I need not tell you how to make the other two ſides, for as it is an equilateral triangle, all three ſides will be of equal length.

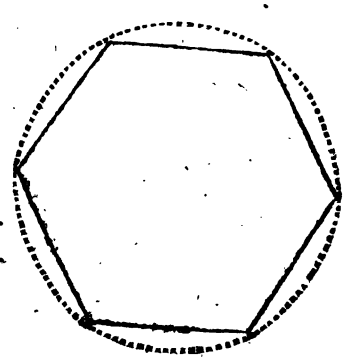
*To make a pentagon, or five-ſided figure.*

Draw firſt an obſcure circle, as ACBD; then draw a diameter from A to B; make another diameter CD perpendicular to the firſt; then taking with your compaſſes the length of the ſemidiameter, ſet one point in A, and make the marks E, F, drawing a line between them, as you did to make a triangle. Next, ſet one point of your compaſſes in the interſection at *g*, and extend the other to C, draw the arch CH: and the chord of this arch, *viz.* the line CIH, will be the ſide of a pentagon, and the greateſt five-ſided figure that can be made within that circle. With this extent of your compaſſes, you may mark out five points round the circle, and joining thoſe points with right lines, the figure will be finiſhed.




*To make a hexagon, or ſix-ſided figure.*

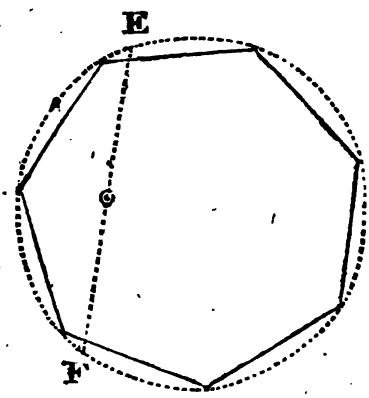
Drawan obſcure circle, as you ſee here, and then, without altering the extent of the compaſſes, mark out the hexagon required round the circle; for the ſemidiameter of any circle is the ſide of the greateſt hexagon that can be made within the ſame circle.



This

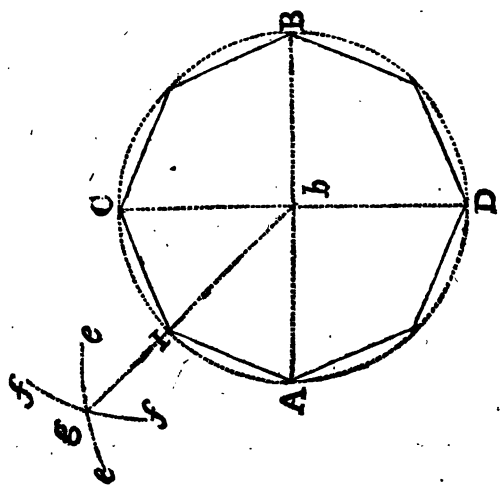
This is the way coopers uſe to make heads for their caſks.

*To make a heptagon, or figure of ſeven equal ſides and angles.*




You muſt begin and proceed, as if you were going to deſcribe an equilateral triangle in a circle, till you have drawn the line EF; then taking with your compaſſes the half of that line, *viz.* from ⊙ to E, or from ⊙ to F, mark out round the circle your heptagon; for the half of the line EF is the ſide of it.

*To make an octagon, commonly called an eight-ſquare figure.*




Firſt,

Firſt, Make a circle.

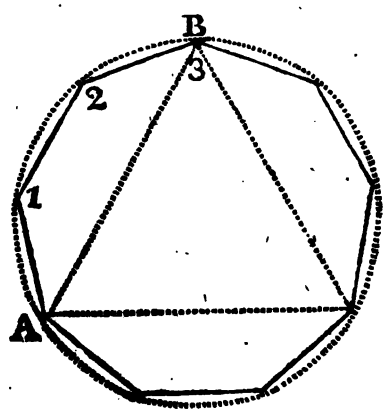
Secondly, Divide it into four equal parts by two diameters, the one perpendicular to the other, as AB and CD.

Thirdly, Set one foot of the compaſſes in A, and make the arch *ee*; alſo with the ſame extent ſet one foot in C, and make the arch *ff*; then through the interſection of the two arches draw a line to the center, viz. *g h*.

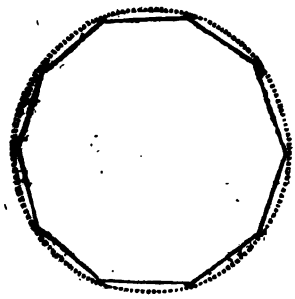
Laſtly, Draw the line IC or IA, either of which is the ſide of an octagon.

## *To make a nonagon.*

Firſt, Make a circle, and an equilateral triangle in it, as you were taught at Prob. XIII. Then divide the arch AB into three equal parts, as A 1, 12, and B 2. Laſtly, draw the lines A 1, 12, 2 B, *&c.* quite round the circle, and the nonagon will be compleated.



*To make a decagon.*

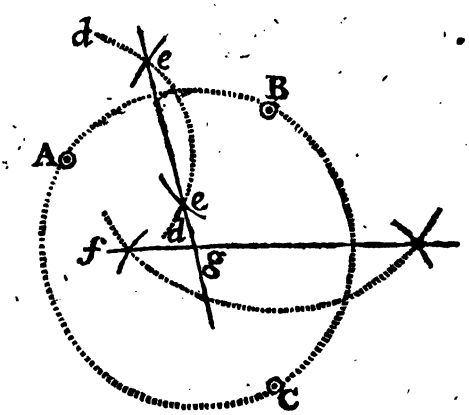


You muſt work altogether as you did in making a pentagon. See the pentagon above, where the diſtance from the center K, (ſee the laſt figure but 4) to the point at H, is the ſide of a decagon, or ten-ſided figure.

## PROB. XIV.

*Three points being given: To deſcribe a circle, whoſe circumference ſhall paſs through thoſe given points, provided they are not in a ſtrait line.*

Let A, B, C, be the three points given; firſt ſetting one foot of your compaſſes in A, open them to any convenient wideneſs, more than half the



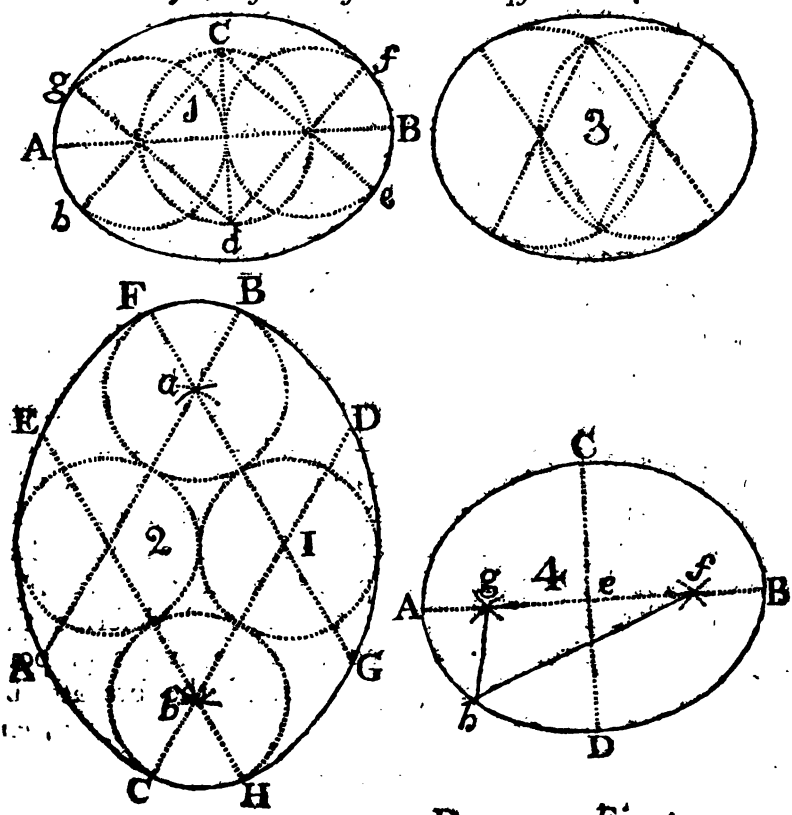

diſtance

distance between A and B, and describe the arch *dd*; then, without altering the extent, set one point in B, and cross the first arch at *e* and *e*; through those two intersections draw the line *ee*.

The very same you must do between B and C, and draw the line *ff*; where those two lines intersect each other, as at *g*, there is the center of the circle required; therefore setting one foot of your compasses in *g*, extend the other to any of the points given, and describe the circle ABC. Note, the centre of a triangle is found the same way.

PROB. XV.

*To describe the carpenter's or common oval, several ways; also to describe an ellipsis.*




D *Fig.* 1.

*Fig.* 1. Deſcribe a circle at pleaſure, and through the center thereof draw an indefinite right line, as AB. On the two points where the circumference of this circle cut the line AB, as centers deſcribe circles with the ſame radius as before; draw *dc* perpendicular to AB, and paſſing through the center of the middle circle. From the points C and *d*, draw C*e*, C*h* and *df*, *dg*: ſet one foot of the compaſſes in D, and extend the other to *g*, deſcribe the arch *gf*; with the ſame extent, and one foot in C, deſcribe the arch *he*; theſe arches together, with the circular parts *fe*, *gh*, will form the oval A*gf*B*ch*A required.

*Fig.* 2. Draw any trapezium at pleaſure, and produce the ſides indefinitely towards A, E, F, B, &c. Upon each angular point of this trapezium, as a center with a radius equal to half the ſide thereof, deſcribe a circle; which done, from the centers 1, 2, with the radii 1F, 2B, deſcribe the arches FC, BH, and the oval is finiſhed.

*Fig.* 3. This needs no deſcription, it being ſo like the two former figures, and eaſier than either of them.

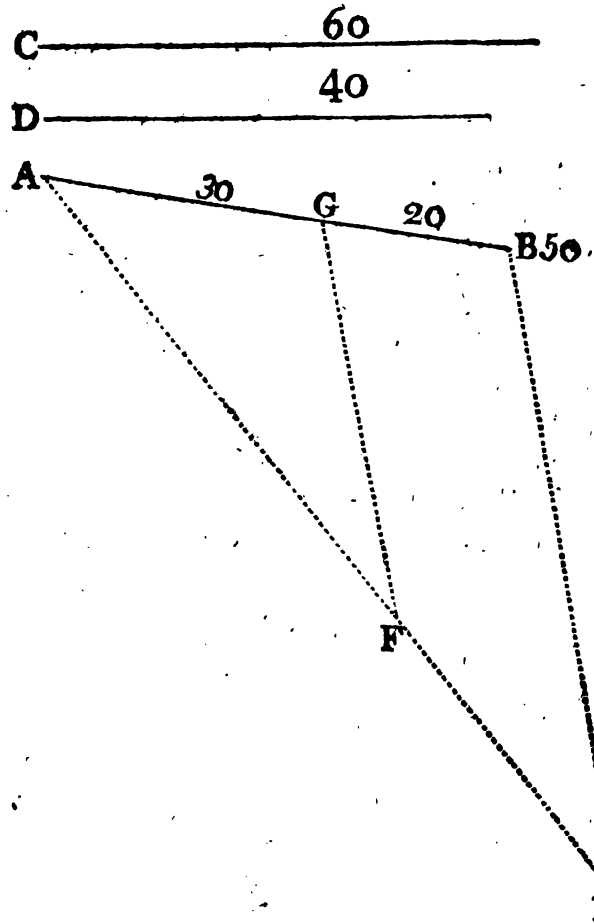
Here note, that you may make the ovals 1 and 3 of any determined length; for in the length of the firſt, there is four ſemidiameters of the ſmall circles; and in the laſt but three. If therefore any line was given you, of which length an oval was required, you muſt take in your compaſſes only the fourth part of the line to make the oval *Fig.* 1, but the third part to make the oval *Fig.* 3, and with that extent you muſt deſcribe the ſmall circles: the breadth will be always proportional to the length. But if the breadth be given,

given, you muſt deſcribe the circles with one fourth part thereof, to make the oval *Fig.* 2.

*Fig.* 4. This ellipſis is to be deſcribed by having the length and breadth both given. Let AB be the length, CD the breadth of the required ellipſis. Firſt, Lay down the line AB equal to the given length, and croſs it in the middle with the perpendicular CD, equal to the given breadth. Secondly, Take in half the line AB with your compaſſes, *viz.* A *e*, or B *e*; ſet one foot in C, and make two marks upon the line AB, *viz.* *f* and *g*; alſo with the ſame extent ſet one foot in D, and croſs the former marks at *f* and *g*. Thirdly, at the point *f* and *g* fix two pins; or if it be a garden-plat, or the like, two ſtrong ſticks. Then putting a line about them, make faſt the two ends at ſuch an exact length, that, ſtretching by the two pins, the bent of the line may exactly touch A or B, or C or D, or *h*, as in this diagram it does at *h*; ſo moving the line ſtill round, it will deſcribe a true ellipſis.

## PROB. XVI.

*To divide a given line into two parts, which may be in such proportion to each other, as two given lines are.*




Let

Let AB be the given line to be divided in ſuch proportion as the line C is to the line D.

Firſt, From A draw a line at pleaſure, as AE; then taking with your compaſſes the line C, ſet it off from A towards E, which will fall at F: alſo take the line D, and ſet off from F to E.

Secondly, Draw the line EB; and from F draw FG parallel to EB, which ſhall interſect the given line AB in the point required, *viz.* at G; thus will AG and GB be in like proportion to each other, as C and D are.

*Example by arithmetic.*

The line C is 60 feet, perches, or any thing elſe; the line D is 40; the line AB is 50; which is required to divide it in ſuch proportion as 60 to 40. Firſt add the two lines C and D together, and they make 100: then ſay, If 100, the whole, give 60 for its greater part, what ſhall 50, the whole line AB, give for its greater proportional part? Multiply 50 by 60, it makes 3000; which, divided by 100, produces 30 for the greater part; which 30 taken from 50, leaves 20 for the leſſer part: as therefore 60 is to 40, ſo is 30 to 20.

## PROB. XVII.

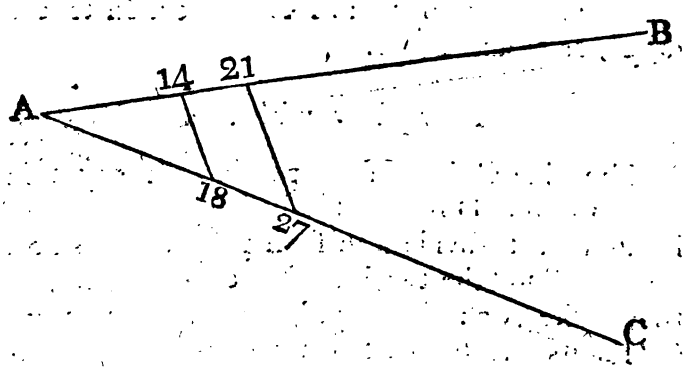
*To find a fourth in proportional to three given lines.*

Let ABC be the three given lines: it is required to find a fourth line, which may be in ſuch proportion to C, as B is to A,

A——14
B——18
C——21

which is no more than performing the *Rule of Three* by lines; thus, If A 14 give B 18, then what ſhall C 21 give? Anſwer 27. But to perform the ſame geometrically, work thus:

Firſt make any Angle, as BAC: then take with your compaſſes the firſt line A, and ſet it from A to 14. Alſo take the ſecond line B, and ſet it from A to 18; draw the line 14, 18. Then take




the third line C with your compaſſes, and ſet it from A to 21. From 21, draw 21, 27 parallel to 14, 18. Then will A 27, be the length of your fourth line required.

And here for a while I ſhall leave theſe *Problems*, till I come to ſhew you how to divide any piece of land; and to lay out any piece of a given quantity of acres into any form or figure required: and in the mean time I ſhall ſhew you in the next chapter, what is neceſſary to be known relating to meaſures of various kinds.

CHAP.

## CHAP. II.

### *Of* MEASURES.

AND first of long measures; which is either inches, feet, yards, perches, chains, *&c.* Note That twelve inches make one foot, three feet one yard, five yards and an half one pole or perch, four perches one chain of *Gunter*'s, eighty chains one mile. But if you would bring one sort of measure into another, you must work by *Multiplication* or *Division*. As for example: Suppose you would know how many inches are contained in twenty yards; first, reduce the yards into feet by multiplying them by 3, because 3 feet make one yard, the product is 60; which multiplied by 12 the number of inches in one foot, gives 720, and so many inches are contained in 20 yards length.

On the contrary, if you would know how many yards there are in 720 inches, you must first divide 720 by 12, the quotient is 60 feet; that again divided by 3, the quotient is 20 yards. The like you must do with any other measure, as perches, chains, &c. of which more hereafter.

| Long. | Link | Foot | Yard | Perch | Chain | Mile |
|---|---|---|---|---|---|---|
| Inches | 7.92 | 12 | 36 | 198 | 792 | 63360 |
| | Link | 1.515 | 4.56 | 25 | 100 | 8000 |
| | | Feet | 3 | 16.5 | 66 | 5280 |
| | | | Yard | 5.5 | 22 | 1760 |
| | | | | Perch | 4 | 320 |
| | | | | | Chain | 80 |

See this table of the long meaſure annexed, the uſe whereof is very eaſy. If you would know how many feet in length go to make one chain, look for chain at the top, and at the left hand for feet; againſt which, in the common angle of meeting, is 66; ſo many feet are contained in one chain.

But becauſe Mr. *Gunter*'s chain is moſt in uſe among ſurveyors for meaſuring of lines, I ſhall chiefly inſiſt on that meaſure, it being the beſt in uſe for lands.

This chain contains in length 4 poles or 66 feet, and is divided into 100 links, each link is therefore in length $7\frac{92}{100}$ inches: if you would turn any number of chains into feet, you muſt multiply them by 66, as 100 chains multiplied by 66, make 660 feet; but if you have links to your chains, to be turned into feet, and parts of feet, you muſt ſet down the chains and links, as if they were one whole number; and after having multiplied that number by 66, cut off from the product the two laſt figures to the right hand, which will be the hundredth parts of a foot, and thoſe on the left hand the feet required.

## EXAMPLE.

Let it be required to know how many feet there are in 15 chains, 25 links.

| | |
|---|---|
| I ſet down thus the *Multiplicand* | 15,25 |
| The num. of feet in one chain *Multiplic.* | 66 |
| | 9150 |
| | 9150 |
| *Product* | 1006\|50 feet. |

The

The *product* is 1006 $\frac{1}{100}$. This is ſo plain, it needs no other example.

But now on the other hand, if one thouſand and ſix feet and an half were given you to reduce into chains and links, you muſt divide 1006.50 by 66, the quotient will be 1.525, *viz.* 15 chains, 25 links. But for thoſe that do not well underſtand *Decimal Arithmetic*, and may perhaps meet with more difficult queſtions of this nature, I have inſerted the following table:

A TABLE, ſhewing how many feet, and parts of a foot; alſo how many perches, and parts of a perch, are contained in any number of chains and links, from one link to one hundred chains.

| Links. | Feet. | Parts of a Foot. | Perches. | Parts of a Perch. | Chains. | Feet. | Perches. |
|---|---|---|---|---|---|---|---|
| 1 | 00 | . 66 | 0 | . 04 | 1 | 66 | 4 |
| 2 | 01 | . 32 | 0 | . 08 | 2 | 132 | 8 |
| 3 | 01 | . 98 | 0 | . 12 | 3 | 198 | 12 |
| 4 | 02 | . 64 | 0 | . 16 | 4 | 264 | 16 |
| 5 | 03 | . 30 | 0 | . 20 | 5 | 330 | 20 |
| 6 | 03 | . 96 | 0 | . 24 | 6 | 390 | 24 |
| 7 | 04 | . 62 | 0 | . 28 | 7 | 462 | 28 |
| 8 | 05 | . 28 | 0 | . 32 | 8 | 528 | 32 |
| 9 | 05 | . 94 | 0 | . 36 | 9 | 594 | 36 |
| 10 | 06 | . 60 | 0 | . 40 | 10 | 660 | 40 |
| 20 | 13 | . 20 | 0 | . 80 | 20 | 1320 | 80 |
| 30 | 19 | . 80 | 1 | . 20 | 30 | 1980 | 120 |
| 40 | 26 | . 40 | 1 | . 60 | 40 | 2640 | 160 |
| 50 | 33 | . 00 | 2 | . 00 | 50 | 3300 | 200 |
| 60 | 39 | . 60 | 2 | . 40 | 60 | 3960 | 240 |
| 70 | 46 | . 20 | 2 | . 80 | 70 | 4620 | 280 |
| 80 | 52 | . 80 | 3 | . 20 | 80 | 5280 | 320 |
| 90 | 59 | . 40 | 3 | . 60 | 90 | 5940 | 360 |
| 100 | 66 | . 00 | 4 | . 00 | 100 | 6600 | 400 |

*The Explanation of the Table.*

If you would know how many feet are contained in 20 of Mr. *Gunter's* chains:

Firſt, Under title *Chains* ſeek for 20; and right againſt it, under title *Feet*, ſtands 1320, the number of feet contained in twenty chains. Alſo under title *Perches* ſtands 80, the number of perches contained in twenty chains.

Again,

Again, If you would know how many feet are contained in eight links only of the chain, ſeek 8 under title *Links*, and right againſt it ſtands 05.28, which is five feet $\frac{28}{100}$ of a foot, ſomething more than five feet and a quarter. Alſo under title *Perches*, and parts of a perch, ſtands 0.32; which ſignifies that 8 links contain 0 perch $\frac{32}{100}$ of a perch. But, to know how many feet are contained in any number of chains and links together, firſt ſeek the feet anſwering to the whole chains, and write them down next the firſt anſwering the links; and adding them to the other, you will have your deſire. *Example:* In 15 chains, 25 links, how many feet? Firſt, by the table I find 10 chains to contain 660 feet, which I write down thus:

| | | *Chains, Feet, Parts.* | | |
|---|---|---|---|---|
| | | 10 | 660 | |
| | | 5 | 330 | |
| | *Links* | 25 | 13 | 20 |
| | | 5 | 3 | 30 |
| | *Added* | | 1006 | 50 |

And when you have added them together, you find the ſum to be 1006 feet, and $\frac{50}{100}$ of a foot that is contained in 15 chains, 25 links.

In like manner, if it had been aſked how many perches are contained in 15 chains, 25 links?

In

| | | *Perch.* | *Parts.* |
|---|---|---|---|
| In the table againſt 10 chains ſtands | | 40 | |
| | 5 | 20 | |
| | 20 *Links.* | 00 | 80 |
| | 5 *Links.* | 00 | 20 |
| Anſwer, 60 *Perches.* | | 60 | 100 |

Obſerve, that the foregoing table is as large again as it need to be; for you ſee both the columns are alike in figures and only differenced by points. I made it ſo for your clearer underſtanding of it; which, when you well do, you need uſe no more than one column; which if you pleaſe, you may have placed on a ſcale, or any other inſtrument. But now, to bring a leſs meaſure into a greater, requires diviſion, and is therefore more troubleſome than to bring a greater into a leſs, which requires only multiplication: I have therefore, for your eaſe, hereto annexed a large table, with which, by inſpection only, or at moſt by a little eaſy addition, as in the former, you may change any number of feet into chains, links, and parts of a link (Mr. *Gunter*'s chain is here uſed) alſo into perches, and parts of a perch.

A TABLE,

A TABLE, ſhewing how many Chains, Links, and Parts of a Link; alſo how many Perches, and Parts of a Perch, are contained in any Number of Feet, from 1 to 10000.

| Feet. | Chain | Link | P.of L | Per. | P.of Per. |
|---|---|---|---|---|---|
| 1 | 0 | 1 | 515 | 0 | 060 |
| 2 | 0 | 3 | 030 | 0 | 121 |
| 3 | 0 | 4 | 545 | 0 | 181 |
| 4 | 0 | 6 | 060 | 0 | 242 |
| 5 | 0 | 7 | 575 | 0 | 303 |
| 6 | 0 | 9 | 090 | 0 | 363 |
| 7 | 0 | 10 | 606 | 0 | 424 |
| 8 | 0 | 12 | 121 | 0 | 484 |
| 9 | 0 | 13 | 636 | 0 | 545 |
| 10 | 0 | 15 | 151 | 0 | 606 |
| 20 | 0 | 30 | 303 | 1 | 212 |
| 30 | 0 | 45 | 454 | 1 | 818 |
| 40 | 0 | 60 | 606 | 2 | 424 |
| 50 | 0 | 75 | 757 | 3 | 030 |
| 60 | 0 | 90 | 909 | 3 | 636 |
| 70 | 1 | 06 | 060 | 4 | 424 |
| 80 | 1 | 21 | 212 | 4 | 848 |
| 90 | 1 | 36 | 363 | 5 | 454 |
| 100 | 1 | 51 | 515 | 6 | 060 |
| 200 | 3 | 03 | 030 | 12 | 121 |
| 300 | 4 | 54 | 545 | 18 | 181 |
| 400 | 6 | 06 | 060 | 24 | 242 |
| 500 | 7 | 57 | 575 | 30 | 303 |
| 600 | 9 | 09 | 090 | 36 | 363 |
| 700 | 10 | 60 | 606 | 42 | 424 |
| 800 | 12 | 12 | 121 | 48 | 484 |
| 900 | 13 | 63 | 636 | 54 | 545 |
| 1000 | 15 | 15 | 151 | 60 | 606 |
| 2000 | 30 | 30 | 303 | 121 | 212 |
| 3000 | 45 | 45 | 454 | 181 | 818 |
| 4000 | 60 | 60 | 606 | 242 | 424 |
| 5000 | 75 | 75 | 757 | 303 | 030 |
| 6000 | 90 | 90 | 909 | 363 | 630 |
| 7000 | 106 | 06 | 060 | 424 | 242 |
| 8000 | 121 | 21 | 212 | 484 | 848 |
| 9000 | 136 | 36 | 363 | 545 | 454 |
| 10000 | 151 | 51 | 515 | 606 | 060 |

This

This table is like the former, and needs not much explanation. However, I will give an example or two.

Admit I would know how many chains in length are contained in 500 feet. Firſt, in the left-hand column, under title *Feet*, I look out 500, and right againſt it I find 7 chains, 57 links 575 parts of 1000 of a link, or 7 chains, 57 $\frac{575}{1000}$ links. So likewiſe under title *Perches*, I find 30 $\frac{303}{1000}$ perches. But if you would know how many feet the fraction $\frac{303}{1000}$ contains, you muſt ſeek for 303 in the column titled *Parts of a Perch*, and right againſt it you will find 5 feet. So I ſay that 500 feet is 30 perches, 6 feet.

Again, I would know how many chains and links there are in 15045 feet. Firſt ſeek for 10000, and write down the chains, links, and parts of a link contained therein. Do the like by 5000; alſo by 40 and 5. Laſtly, adding them together, you have your deſire.

| *Feet.* | *Chain.* | *Link.* | *Parts.* |
|---|---|---|---|
| 10000 — | 151 | 51 | 515 |
| 5000 — | 75 | 75 | 757 |
| 40 — | 0 | 60 | 606 |
| 5 — | 0 | 7 | 575 |
| *Added make* —— | 227 | 95 | 453 |

Anſwer, 227 chains, 95 links, and 453 parts are contained in 15045 feet.

One *Example* more will be ſufficient for the uſe of this table.

How many perches do 10573 feet make?

*Feet.*

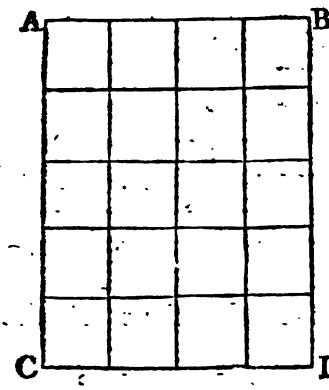
| *Feet.* | *Perches.* | *Parts.* |
|---|---|---|
| 10000 | 606 | 060 |
| 500 | 30 | 303 |
| 70 | 4 | 242 |
| 3 | 0 | 181 |
| *Add*—— | 640 | 786 |

The anſwer is, 640 perches, and $\frac{786}{1000}$ of a perch, or 13 feet. A furlong is 40 perches in length; 8 furlongs make 1 mile. Thus much for *Long Meaſure*: I ſhall now proceed to

*Square Meaſure.*

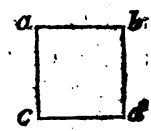
Planometry, or the meaſuring Superficies or Planes (as Sir *Jonas More* ſays) is done with the ſquares of ſuch meaſures, as a ſquare foot, a ſquare perch, or chain; that is to ſay, by ſquares whoſe ſides are a foot, a perch, or chain; and the content of any ſuperficies is ſaid to be found, when we know how many ſuch ſquares it contains.

As for example: Suppoſe ABCD was a piece of land, and the length of the line AB or CD was 4 perches; alſo the length of the line AC or BD was 5 perches; I ſay, that piece of land contains 20 ſquare perches, as you may ſee it here divided; every little ſquare being a perch, having a perch in length for its ſide. If you lay down a ſquare figure, whoſe



whoſe ſide is 1 foot, and at the end of every inch you draw lines croſſing one another, as theſe here, you will divide that ſquare foot into 114 little ſquares, or ſquare inches.

Or thus: The line *a b* is a perch long, or 16 feet ½, ſo is the line *b d*, and the other 2 lines: the whole figure *a b c d* is called a ſquare perch.




But before we go any farther, take this table following of ſquare meaſure.

## A TABLE of SQUARE MEASURE.

| | Inch. | Links. | Feet. | Yard. | Pace. | Perch. | Chain | Acre | Mile |
|---|---|---|---|---|---|---|---|---|---|
| Inch | 2 | 1 | | | | | | | |
| Links | 62.7264 | | | | | | | | |
| Feet | 144 | 2.295 | 1 | | | | | | |
| Yards | 1296 | 20.755 | 9 | 1 | | | | | |
| Pace | 3600 | 57.381 | 25 | 2.778 | 1 | | | | |
| Perch | 39204 | 625 | 272.25 | 30.25 | 10.89 | 1 | | | |
| Chain | 627264 | 10000 | 4356 | 484 | 174.24 | 16 | 1 | | |
| Acre | 6272640 | 100000 | 43560 | 4840 | 1742.4 | 160 | 10 | 1 | |
| Mile | 40144896000 | 6400000 | 2787840 | 309760 | 111513.6 | 10240 | 640 | 64 | 1 |

1 Mile

This Table is like the former of long meaſure, and the uſe of it is the ſame.

*Example:* If you would know how many ſquare feet are contained in one chain, look for the feet at top, and chain on the ſide, and in the common angle of meeting ſtands 4356, ſo many ſquare feet are contained in one ſquare chain.

The common meaſure for land is the acre, which by ſtatute is appointed to contain 160 ſquare perches; and it matters not what form the acre is of, ſo it contains juſt 160 ſquare perches; as in a right-angled parallelogram, 10 perches one way, and 16 another, contain an acre: ſo does 8 one way, and 20 another; and 4 one way, and 40 another. If then, having one ſide given in perches, you would know how far you muſt go on the perpendicular to cut off an acre; you muſt divide 160 (the number of ſquare perches in an acre) by the given ſide, the quotient is your deſire. As for example: the given ſide is 20 perches, divide 160 by 20, the quotient is 8: by that I know, that 20 perches one way, and 8 another, including a right angle, will be the two ſides of an acre; the other two ſides muſt be parallel to theſe.

And here I think it convenient to infert this neceſſary table, ſhewing the length and breadth of an acre in perches, feet, and parts of a foot. But if your given ſide had been in any other ſort of meaſure; as for inſtance in yards, you muſt then have found the ſquare yards in an acre, and that number you muſt have divided by the given number of yards, the quotient would have anſwered the queſtion.

EXAMPLE.

## EXAMPLE.

If 44 yards be given for the breadth, how many yards muſt there be in length to contain juſt one acre?

| Breadth | Length of an Acre. | |
|---|---|---|
| Perches. | Perches. | Feet. |
| 10 | 16 | 0 |
| 11 | 14 | 9 |
| 12 | 13 | $5\frac{1}{2}$ |
| 13 | 12 | $5\frac{1}{13}$ |
| 14 | 11 | $7\frac{1}{2}$ |
| 15 | 10 | 11 |
| 16 | 10 | 0 |
| 17 | 9 | $6\frac{9}{17}$ |
| 18 | 8 | $14\frac{8}{18}$ |
| 19 | 8 | $6\frac{1}{19}$ |
| 20 | 8 | 0 |
| 21 | 7 | $10\frac{1}{2}$ |
| 22 | 7 | $4\frac{1}{2}$ |
| 23 | 6 | $15\frac{1}{4}$ |
| 24 | 6 | 11 |
| 25 | 6 | $7\frac{7}{25}$ |
| 26 | 6 | $2\frac{1}{26}$ |
| 27 | 5 | 15 |

| Breadth | Length of an Acre. | |
|---|---|---|
| Perches. | Perches. | Feet. |
| 28 | 5 | $11\frac{3}{4}$ |
| 29 | 5 | $8\frac{13}{29}$ |
| 30 | 5 | $5\frac{1}{2}$ |
| 31 | 5 | $2\frac{1}{3}$ |
| 32 | 5 | 0 |
| 33 | 4 | 14 |
| 34 | 4 | $11\frac{1}{3}$ |
| 35 | 4 | $0\frac{5}{21}$ |
| 36 | 4 | $7\frac{1}{2}$ |
| 37 | 4 | $5\frac{1}{2}$ |
| 38 | 4 | $3\frac{1}{2}$ |
| 39 | 4 | $1\frac{1}{2}$ |
| 40 | 4 | 0 |
| 41 | 3 | $14\frac{21}{41}$ |
| 42 | 3 | $13\frac{1}{3}$ |
| 43 | 3 | $11\frac{11}{43}$ |
| 44 | 3 | $10\frac{1}{2}$ |
| 45 | 3 | $2\frac{1}{2}$ |

First I find, that an acre contains 4840 ſquare yards, which I divide by 44, the quotient is 110 for the length of an acre. And thus knowing well how to take the length and breadth of an acre, you may alſo, by the ſame way, know how to lay down any number of acres together; of which more hereafter.

Reducing of one ſort of ſquare meaſure to another, is done as before taught in long meaſure by multiplication and diviſion. And becauſe Mr. *Gunter*'s chain is chiefly uſed by ſurveyors, I ſhall only inſtance in that, and ſhew you how to turn any number of chains and links into acres, roods, and perches. Note, that a rood is the fourth part of an acre.

And firſt, obſerve that 10 ſquare chains make 1 acre, that is to ſay, 1 chain in breadth, and 10 in length; or 2 in breadth, and 5 in length, is an acre, as you may ſee by the ſmall table here annexed.

| Length of an Acre. Chains. | Breadth of an Acre. Chains. | Links. | Parts of a Link. |
|---|---|---|---|
| 1 | | | |
| 2 | 10 | 00 | |
| 3 | 5 | 00 | |
| 4 | 3 | 33 | 333 |
| 5 | 2 | 50 | |
| 6 | 2 | 00 | |
| 7 | 1 | 66 | 666 |
| 8 | 1 | 42 | 285 |
| 9 | 1 | 25 | |
| | 1 | 11 | 111 |

And thus knowing that 10 chains make an acre, if any number of chains be given to be turned into acres, you muſt divide them by 10, and the quotient will be the number of acres contained in ſo many chains. But this diviſion is abbreviated by only cutting off the laſt figure; thus if 1590 chains were given to be turned into acres, by cutting off the laſt figure 159|0, there is left 159 acres, which is the ſame thing as if you had divided 1590 by 10. If any chains remain after the diviſion by 10 is ended, they may be reduced into roods and perches; thus, multiply the remaining number of ſquare chains by 4, and cut off one figure from the right hand towards the left, the remaining figures will denote the number of ſquare roods contained in the ſaid chains; this done multiply the figure cut off by 40; then from the product, cut off one figure in the ſame manner as before, and you will have the number of perches required, expreſſed by the remaining figures towards the left hand.

EXAMPLE.

## EXAMPLE.

In 1599 ſquare chains, how many acres, roods, and perches?

Acres——1599
4

Roods——3|6
40

Perches——24—0

Anſwer, 159 acres, 3 roods, and 24 perches.

On the contrary, if to any number of acres given you annex a cypher, they will be turned into chains. Thus 99 acres are 990 chains, 100 acres 1000 chains; *&c.* the ſame as if you had multiplied the acres by 10. And if you would turn ſquare chains into ſquare links, annex four cyphers to the number of the chains; thus 990 chains will be 9900000 links, 1000 chains be 10000000 links; the very ſame as if you had multiplied 990 by 10000, the number of ſquare links contained in one chain.

And now, whereas in caſting up the content of a piece of land meaſured by Mr. *Gunter*'s chain (*viz.* multiplying chains and links by chains and links) the product will be ſquare chains and parts; you muſt therefore from that product cut off five figures to find the acres; which is the ſame as dividing the product by 100000 (the number of ſquare links contained in one acre) then multiply the five figures cut off by 4; and from that product cut

off five figures, you will have the roods. Laſtly multiply by 40, and take away (as before) 5 figures, the reſt are perches.

EXAMPLE.

Admit a right angled parallelogram, or long ſquare, to be one way 5 chains, 55 links; and the other way 4 chains, 35 links: I demand the content in acres, roods, and perches?

*Multiplicand* 555
*Multiplicator* 435

2775
1665
2220

Anſwer, 2 *Acres*, 1 *Rood* 26 *Perches*

*Acres* 2|41425
4

*Roods* 1|65700
40

And $\frac{28}{160}$ *Parts of Perch.*

*Perches* 26|28000

Laſtly, Becauſe ſome rather chooſe to caſt up the content of land in perches, I will here briefly ſhew you how it may be done; which is only by dividing by 160 (the number of ſquare perches contained in one acre) the number of perches given.

EXAMPLE.

Admit a parallelogram to be in length 55 perches, and in breadth 45 perches; theſe two multiplied together make 2475 ſquare perches; to turn theſe into

into acres, divide by 160, the quotient is 15 acres, and 75 perches remain; which, to turn into roods, divide by 40, the quotient is 1 rood, and 35 perches remain. So the content of this piece of land is 15 acres, 1 rood, and 35 perches.

Here follows a table to convert perches into acres and roods.

| Perches. | Acres. | Roods. | Perches. |
|---|---|---|---|
| 40 | 0 | 1 | 00 |
| 50 | 0 | 1 | 10 |
| 60 | 0 | 1 | 20 |
| 70 | 0 | 1 | 30 |
| 80 | 0 | 2 | 00 |
| 90 | 0 | 2 | 10 |
| 100 | 0 | 2 | 20 |
| 200 | 1 | 1 | 00 |
| 300 | 1 | 3 | 20 |
| 400 | 2 | 2 | 00 |
| 500 | 3 | 0 | 20 |
| 600 | 3 | 3 | 00 |
| 700 | 4 | 1 | 20 |
| 800 | 5 | 0 | 00 |
| 900 | 5 | 2 | 20 |
| 1000 | 6 | 1 | 00 |
| 2000 | 12 | 2 | 00 |
| 3000 | 18 | 3 | 00 |
| 4000 | 25 | 0 | 00 |
| 5000 | 31 | 1 | 00 |
| 6000 | 37 | 2 | 00 |
| 7000 | 43 | 3 | 00 |
| 8000 | 50 | 0 | 00 |
| 9000 | 56 | 1 | 00 |
| 10000 | 62 | 2 | 00 |
| 20000 | 125 | 0 | 00 |
| 30000 | 187 | 2 | 00 |
| 40000 | 250 | 0 | 00 |
| 50000 | 312 | 2 | 00 |
| 60000 | 375 | 0 | 00 |
| 70000 | 437 | 2 | 00 |
| 80000 | 500 | 0 | 00 |
| 90000 | 562 | 2 | 00 |
| 100000 | 625 | 0 | 00 |

## The Uſe of the TABLE.

In 2475 perches, how many acres and roods?

| | Perch. | Acr. | Rood. | Per. |
|---|---|---|---|---|
| | 2000 | 12 | 2 | 00 |
| | 400 | 2 | 2 | 00 |
| | 70 | 0 | 1 | 30 |
| To which add the odd 5 perches | | 0 | 0 | 05 |
| *Anſwer* | | 15 | 1 | 35 |

## CHAP. V.

### Of Inſtruments and their Uſes.

*And firſt, of the Chain.*

THERE are ſeveral ſorts of chains, as Mr. *Rathbrone*'s of two perches in length; others of one perch long: ſome of 1000 feet in length. But that which is moſt in uſe among ſurveyors (as being indeed the beſt) is Mr. *Gunter*'s, which is 4 pole long, and contains 100 links, each link being $7\frac{92}{100}$ inches in length. The deſcription of this chain, and how to reduce it into any other meaſure, you have at large in the foregoing chapter of meaſures. In this place I ſhall only give you ſome few directions for the uſe of it in meaſuring land.

Take care that they who carry the chain deviate not from a ſtrait line; which you may do by ſtanding at your inſtrument, and looking through the ſights. If you ſee them between you and the mark obſerved, they are in a ſtrait line, otherwiſe not. But without this trouble, they may carry the chain true enough, if he that follows the chain always cauſes him that goeth before to be in a direct line between himſelf and the place they are going to, ſo that as the foreman may always cover the mark from him that goes behind. If they ſwerve from the

the line they will make it longer than it really is, a ſtrait line being the neareſt diſtance that can be between any two places.

Be careful that they who carry the chain, miſtake not a chain either over or under in their account; for if they ſhould the error would be very conſiderable; as ſuppoſe you were to meaſure a field that you knew to be exactly ſquare, and therefore need only meaſure one ſide of it: if the chain-carriers ſhould miſtake but one chain, and tell you the ſide was nine chains when it was really 10, you would make of the field but 8 acres and 16 perches, when it ſhould be 10 acres juſt. And if in ſo ſmall a line ſuch a great error may ariſe, what may be in a greater you may eaſily imagine; but the uſual way to prevent ſuch miſtakes, is to be provided with 10 ſmall ſticks, ſharp at one end, to ſtick in the ground; and let him that goes before, take all the ſticks in his hand at ſetting out, and at the end of every chain ſtick down one, which let him that follows take up: when the 10 ſticks are uſed, you will be ſure they have gone 10 chains: then if the line be longer, let them change the ſticks, and proceed as before, keeping in memory how often they change: they may either change at the end of 10 chains, then the hindmoſt man muſt give the foremoſt all his ſticks; or, which is better, at the end of 11 chains, and then the laſt man muſt give the firſt but nine ſticks, keeping one to himſelf. At every change count the ſticks, for fear leſt you have dropt one, which ſometimes happens.

If you find the chain too long for your uſe, as for ſome lands it is, eſpecially in *America*, you may

then take the half of the chain, and meaſure as before, remembering ſtill, when you put down the meaſure of the lines in your field-book, that you ſet down but the half of the chains, and the odd links; as if a line meaſured by the little chain be 11 chains, 25 links, you muſt ſet down five chains, 75 links; and then in plotting and caſting up it will be the ſame as if you had meaſured by the whole chain.

It is uſual at the end of every 10 links to have a ring, or a piece of braſs fixed, for your more ready reckoning the odd links.

When you put down in your field-book the length of any line, you may ſet it thus, if you pleaſe, with a ſtop between the chains and links, as 15 chains, 15 links, 15.15; or without, as thus, 1515 links, it will be all one in the caſting up.

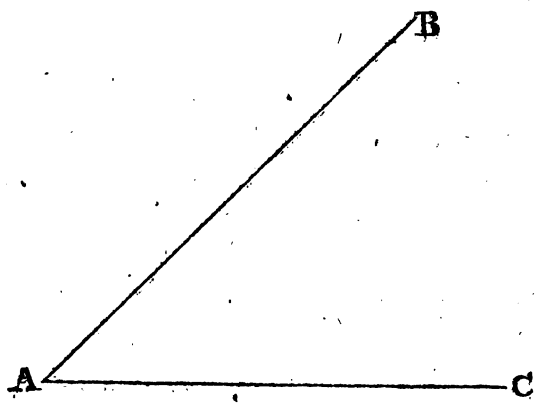
### *Of inſtruments neceſſary for taking of an angle in the field.*

There are but two material things (towards the meaſuring of a piece of land) to be done in the field; the one is to meaſure the lines (which I have ſhewed you how to perform by the chain,) and the other is to take the quantity of an angle included by thoſe lines; for which there are almoſt as many inſtruments as there are ſurveyors. Such among the reſt as are the moſt eſteemed, are the plane table for ſmall incloſures, the ſemicircle for champaign grounds, the circumferentor, the theodolite, *&c.* To deſcribe theſe to you, with their ſeveral parts, how to put them together, take them aſunder, *&c.* is like teaching the art of fencing by book; one hour's uſe of them, or but looking on them in the inſtrument-

inſtrument-maker's ſhop, will better deſcribe them to you, than the reading one hundred ſheets of paper concerning them. Let it ſuffice that the only uſe of them all is no more (or chiefly at moſt) but this, *viz.*

*To take the quantity of an angle.*

As ſuppoſe AB and AC are two hedges, or other fences of a field, the chain ſerves to mea-




ſure the length of the ſides AB or AC, and theſe inſtruments we are ſpeaking of, are to take the angle A. And firſt, by the

*Plane Table.*

Place the table (already fitted for the work, with a ſheet of paper upon it) as nigh to the angle A as you can, the north end of the needle hanging directly over the *flower-de-luce*; then make a mark upon the ſheet of paper at any convenient place for the angle A, and lay the edge of the index to the mark,

mark, turning it about, 'till through the ſights you view the point B, then draw the line AB by the edge of the index. Do the ſame for the line AC, keeping the index ſtill upon the firſt mark, then will you have upon your table an angle equal to the angle in the field.

*To take the quantity of the ſame angle by the ſemicircle.*

Place the center of your ſemicircle in the angular point A, and cauſe marks to be ſet up near B and C, ſo far off the edges, as your inſtrument at A ſtands; then turn the inſtrument about 'till thro' the fixed ſight you ſee the mark at B; there ſcrew it faſt: next turn the moveable index 'till through the ſights thereof you ſee the mark at C, then ſee what degree upon the limb is cut by the index; which let be the 45th, then is the angle ABC 45 degrees.

*To take the ſame angle by the circumferentor.*

Place your inſtrument, as before, at A, with the *flower-de-luce* towards you, direct your ſights to the marks at B, and ſee what degree is cut by the ſouth end of the needle, which let be the 55th; do the ſame to the mark at C, and let the ſouth end of the needle there cut 100; ſubtract the leſſer out of the greater, the remainder is 45, the angle required. If the remainder had been more than 180 degrees, you muſt then have ſubtracted it out of 360, the laſt remainder would have been the angle deſired.

*This*

*This laſt inſtrument* depends wholly upon the needle for taking of angles, which often proves erroneous; the needle yearly of itſelf varying from the true *north*, if there be no iron mines in the earth, or other accidents to draw it aſide, which in mountainous lands are often found: it is therefore the beſt way for the ſurveyor, where he poſſibly can, to take his angles without the help of the needle, as is before ſhewed by the ſemicircle. But in all lands it cannot be done; but we muſt ſometimes make uſe of the needle, and not without exceeding great trouble, as in the thick woods of *Jamaica, Carolina, &c.* It is good, therefore, to have ſuch an inſtrument as a ſemicircle, with which an angle in the field may be taken either with or without the needle, and there is no better inſtrument that I know of, for the ſurveyor's uſe, yet made public; therefore, as I have before ſhewed you, how by the ſemicircle to take an angle without the help of the needle, I ſhall here direct you

*How to take the quantity of an angle in the field by the ſemicircle and needle.*

Screw faſt the inſtrument, with the north end of the needle hanging directly over the *flower-de-luce* in the card; turn the index about till through the ſights you ſee the mark at B; and note what degree the index cuts, which let B be the 40th; move again the index to the mark at C, and note the degree cut, *viz.* 85. Subtract the leſs from the greater, remains 45, the quantity of the angle.

*Or*

*Or thus:*

Turn the whole inſtrument, 'till thro' the fixed ſights you ſee the mark at B; then obſerve what degree upon the card is cut by the needle; which, for example, ſuppoſe the 315th. Turn alſo the inſtrument, till through the ſame ſights you eſpy C, and note the degree upon the card then cut by the needle, which ſuppoſe 270; ſubtract the leſs from the greater, (as before in the working by the circumferentor) remains 45 degrees for the angle. Note, if you turn the *Flower-de-luce* towards the mark, you muſt look at the north end of the needle for your degrees.

Beſides the diviſion of the card of the ſemicircle into 360 equal parts or degrees, it is alſo divided into four quadrants, each containing 90 degrees, beginning at the north and ſouth point, and proceeding both ways till they end in 90 degrees at the eaſt and weſt points; thoſe points are marked contrary, *viz.* Eaſt with a W, and Weſt with an E; becauſe when you turn your inſtrument to the eaſtward, the end of the needle will hang upon the weſt ſide, *&c.*

If by this way of diviſion of the card, you would take the aforeſaid angle, direct the inſtrument ſo, (the *flower-de-luce* from you) 'till through the fixed ſights, you eſpy the mark at B; then ſee what degrees are cut by the north end of the needle, which let be N.E. 44; next direct the inſtrument to C, and the north end of the needle will cut N.E. 89; ſubtract the one from the other, and there will remain 45 degrees for the angle.

But if at the firſt ſight the needle had hung over N.E. 55, and at the ſecond S.E. 80, then take 55 from

from 90, remain 35; take 80 from 90, remains 10; which added to 35, makes 45, the quantity of the angle: moreover if at the firſt ſight the north end of the needle had pointed to N.W. 22, and at the ſecond N.E. 23, theſe two muſt have been added together, and they would have made 45, the angle as before.

Note, if you had turned the ſouth-part of your inſtrument to the marks, then you muſt have had reſpect to the ſouth-end of your needle.

Although I have been ſo long ſhewing you how to take an angle by the needle, yet when we come to ſurvey land by the needle, as you ſhall ſee farther on, we need take but half the pains; for we take not the quantity of the angle included by two lines, but the quantity of the angle each line makes with the meridian; then drawing meridian lines upon paper, which repreſent the needle of the inſtrument, by the help of a protractor, which repreſents the inſtrument, we readily lay down the lines and angles in ſuch proportions as there are in the field.

This way of dividing the card into four quarters each being 90 degrees, is in my opinion for any work the beſt; but there is a greater uſe yet to be made of it, which ſhall hereafter be ſhewed in its proper place.

*Of the Field-Book.*

You muſt always have in readineſs in the field a little book, in which fairly to inſert your angles and lines; which book you may divide by lines into columns, as you ſhall think convenient in your practice; leaving always a large column to the right hand, to put down what remarkable things you meet with in your way, as ponds, brooks, mills, trees, or the like. Thus for example,

ple, if you had taken the angle A, and found it to contain 45 degrees; and meaſured the line AB, and found it to be 12 chains, 55 links, ſet it down in your field-book thus:

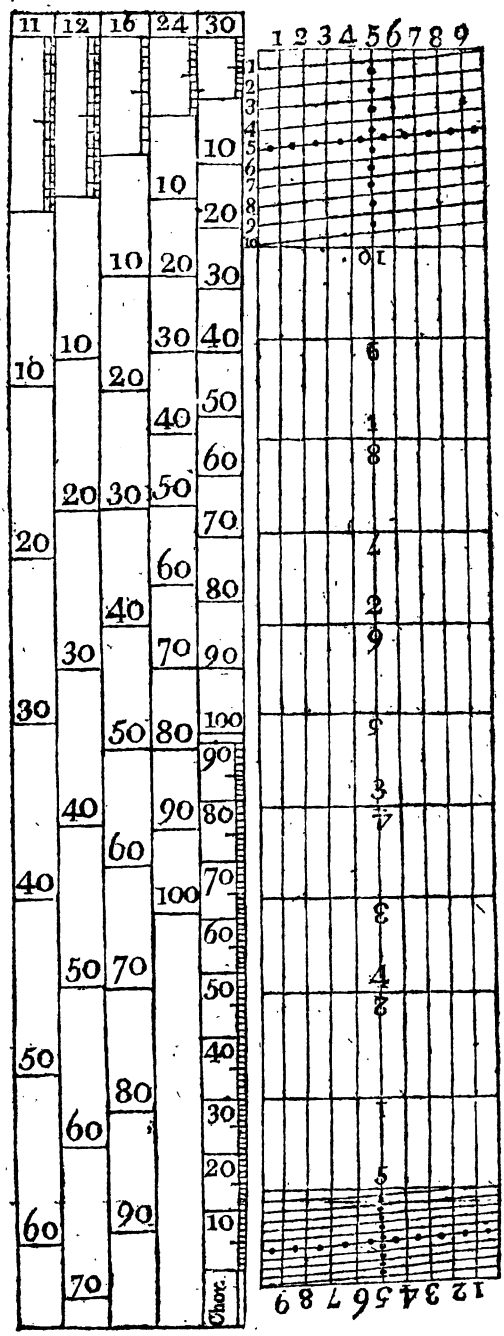
| | Degr. | Min. | Chain. | Link. | |
|---|---|---|---|---|---|
| A | 45 | 00 | 12 | 55 | |
| | | | | | |

or if at A you had only turned the fixed ſights to B, and the needle had then cut 315; in the place of 45, you muſt have put down 315. If you ſurvey by Mr. *Norwood*'s way, there muſt be four columns more for the cardinal points E. W. N. and South. You may alſo make two columns more, if you pleaſe, for off-ſets, to the right and left.

Laſtly, you may chuſe whether you will have any lines or not, if you can write ſtrait, and in good order, the figures directly one under another. For this I leave you chiefly to your own fancy; for I believe there are ſcarce two ſurveyors in *England*, that have exactly the ſame method for their field notes.

## *Of the ſcale.*

Having by the inſtrument before ſpoken of, meaſured the angles and lines in the field; the next thing to be done, is to lay down the ſame upon paper; for which uſe the ſcale ſerves. There are ſeveral ſorts of ſcales, both large and ſmall, according as men have occaſion to uſe them: but all do principally conſiſt of no more but two ſorts of lines: the firſt is of equal parts, for the laying down chains and links; the ſecond a line of chords, for laying down or meaſuring angles. I cannot better explain the ſcale to you, than by ſhewing the figure of ſuch a one as is commonly ſold in ſhops, and teaching how to uſe it.

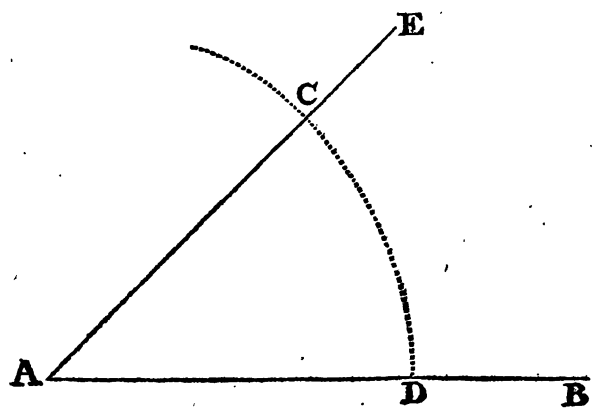

11 12 16 24 30
1 2 3 4 5 6 7 8 9
Chore.

The lines numbered at top with 11, 12, 16, *&c.* are lines of equal parts, containing 11, 12, or 16 equal parts to an inch, foot, yard, *&c.* If now by the line of 11 to an inch you would lay down 10 chains 50 links, look down the line under 11, and ſetting one foot of your compaſſes in 10, cloſe the other till it juſt touch 50 links, or half a chain, in the ſmall diviſions. Then laying your ruler upon the paper, by the ſide thereof, with the ſame extent of the compaſſes mark the points A and B, and draw the right line AB, which will meaſure in length 10 chains, 50 links, by the ſcale of 11 to an inch. On the back-ſide of the ſcale, there is a line of 10 equal parts to an inch, but divided by a diagonal line, for the more readily taking off any required line or number to 100 parts.

A——B

*To lay down an angle by the line of chords.*

Let it be required to make an angle that ſhall contain 45 degrees.




Draw

Draw a line at pleaſure, as AB: then ſetting one foot of your compaſſes at the beginning of the line of chords, ſee that the other fall juſt upon 60 degrees: with that extent ſet one foot in A, and deſcribe the arch CD. Then take from your line of chords 45 degrees, and ſetting one foot in D, make a mark upon the arch at C, through which draw the line AE: ſo ſhall the angle EAB be 45 degrees. If by the line of chords you would erect a line perpendicular to a given one, it is no more than to make an angle that ſhall contain 90 degrees.

The reaſon why you are to take 60 from the line of chords to make your arch by, is, becauſe the chord of 60 degrees is the ſemi-diameter of a circle, whoſe circumference is divided into 360 equal parts.

*To make a regular Polygon, or a figure of 5, 6, 7, 8, or more ſides, by the line of chords.*

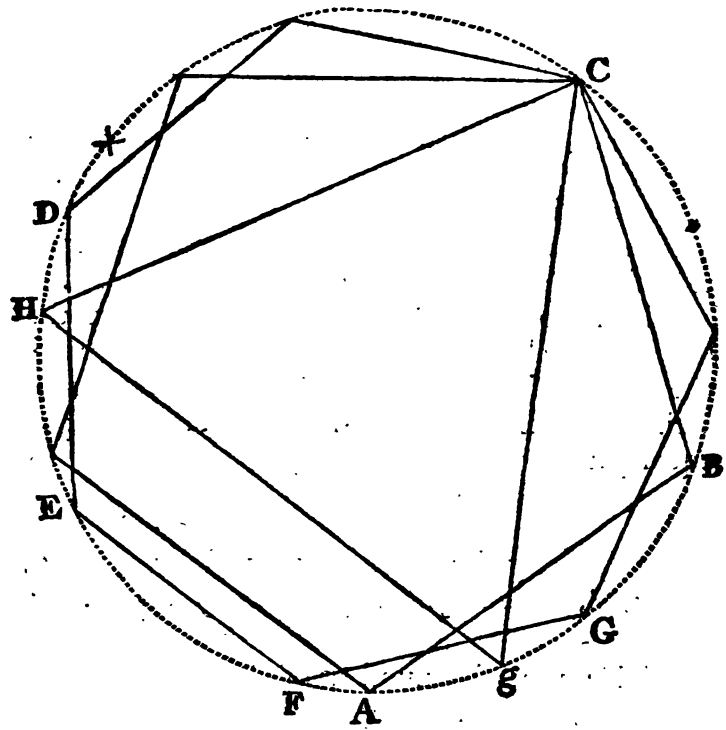
Divide 360, the number of degrees contained in a circle, by the number of ſides you would have your figure to contain; the quotient taken from the line of chords ſhall be one ſide of ſuch a figure.

EXAMPLE.

For to make a pentagon, or a figure of five ſides: divide 360 by 5, the quotient is 72, one ſide of a pentagon.

Take 60 degrees from your line of chords, and deſcribe an obſcure circle; which done take 72 from

your line of chords, and beginning at any part of the circle, ſet off that extent round the circle, as from




B to C, and ſo round till you come to A again. Then having drawn lines between thoſe marks, the pentagon is compleated. The like of any other polygon, be the number of ſides what they will.

Example. For the ſide of a heptagon: divide 360 by 7, the quotient will be 51 degr. 25 min. which if you take from the line of chords, and ſet off round the circle, you will form a heptagon, DE, EF, FG, *&c.* being the ſides thereof.

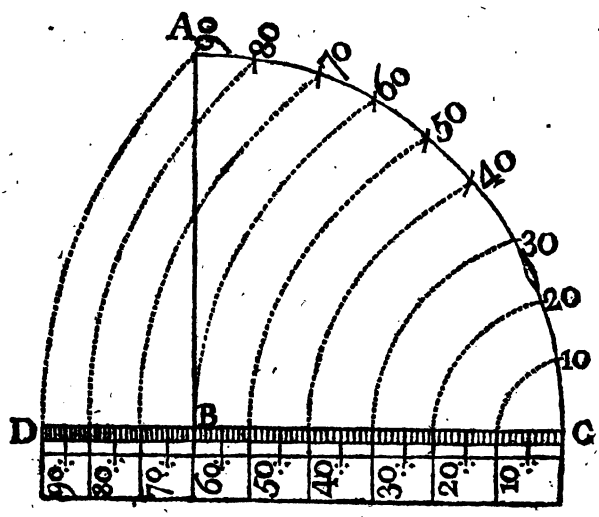
*To inſcribe an equilateral triangle in a circle by the line of chords.*

Firſt, take the whole length of your line of chords, or the chord of 90 degrees, with your compaſſes; this diſtance ſet off from C to *. Then take 30 degrees from the line of chords, and ſet that from * to H. Draw the line CH, which will be one ſide of the greateſt triangle that can be inſcribed in that circle.

Or you may make it by ſetting off twice the ſemi-diameter of the circle; for 60 and 60 is 120, equal to 90 and 30.

*To make a line of chords.*

Firſt, Make a quadrant, or the fourth part of a



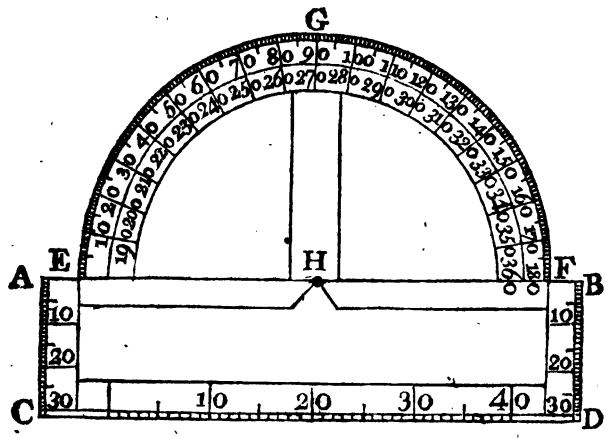

 circle,

circle, as ABC; divide the arch thereof, *viz.* AC, into 90 equal parts; which you may do by dividing it firſt into three equal parts, and every of thoſe diviſions into three equal parts more, and every of the laſt diviſions into ten equal parts.

Secondly, continue the ſemi-diameter BC to any convenient length, as to D. Then ſetting one foot of your compaſſes in C, let the other fall on 90, and deſcribe the arch 90, 90. So likewiſe 80, 80; 70, 70, *&c.* then will CD be the line of chords, and theſe arches cutting it into unequal parts, conſtitute the true diviſions thereof, as you may ſee by the figure: you may, if you pleaſe, draw lines parallel to DC, as I have done here for the better diſtinguiſhing every tenth and fifth figure.

## *Of the Protractor.*

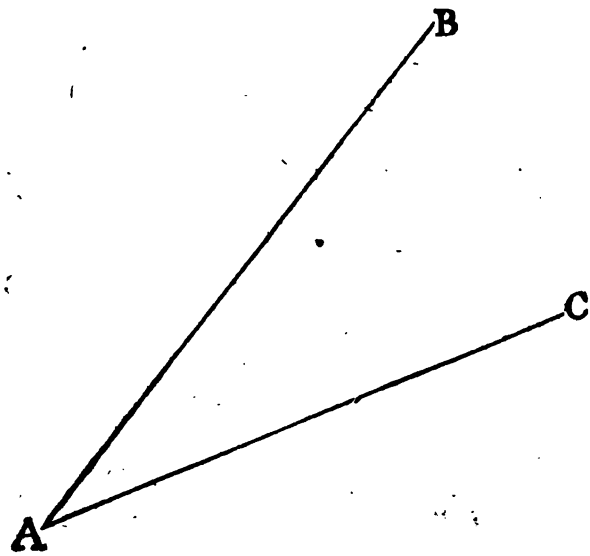
The protractor is an inſtrument with which, with more eaſe and expedition, you may lay down an angle, than you can by the line of chords: alſo when you have ſurveyed by the needle, by placing the diameter of the protractor upon a meridian line made upon your paper, you may readily with a needle upon the arch of the protractor, ſet off the true ſituation of any line from the meridian, without ſcratching the paper, as may happen if you uſe the line of chords. It is graduated together like the braſs limb of a ſemicircle, performing the ſame upon paper, as that inſtrument did in the field; ſee here the figure of it.




For the uſe of the protractor, you muſt have a fine ſewing needle, put into a ſmall handle of wood, or ivory, or the like, which is to put through the center of the protractor, to any point aſſigned upon the paper, that the protractor may turn round upon it.

### *To lay down an angle with the Protractor.*

If it were required by the protractor to lay down an angle of 30 degrees, draw the line AB, then take the protractor, and putting a needle through the center point thereof, place the needle in A, ſo that the center of the protractor may lie juſt upon the end of the line at A, move the protractor about till you find the diameter thereof lie upon the line AB; then at 30 degrees upon the arch,




with your protracting needle make a mark upon the paper as at C; draw the line CA, which ſhall make an angle, as BAC, of 30 degrees.

If you ſurvey according to Mr. *Norwood*'s method before ſpoken of, it will be neceſſary to have the arch of your protractor divided accordingly, *viz.* into two quadrants, or twice 90 degrees.

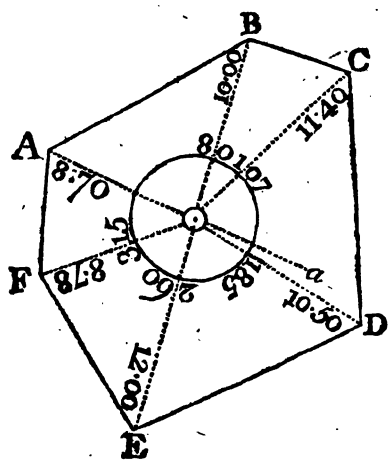
I need ſay no more of a protractor, any ingenious man may eaſily find the ſeveral uſes thereof; it being, as it were, but only an epitome of inſtruments.

CHAP.

## CHAP. VI.

*To take a plot of a field at one ſtation in any place thereof, from whence you can ſee all the angles by the ſemicircle.*

ADmit ABCDEF to repreſent a field, of which you are to take the plot: Firſt, ſet your ſemicircle upon the ſtaff at any convenient place thereof, as at ⊙, and cauſe marks to be ſet up in every angle: direct your inſtrument, the *flower-de-luce* being from you, to any one angle: as for example to A; and eſpying the mark at A through the fixed ſights, ſcrew faſt the inſtrument; then turn



the moveable index about (the ſemi-circle remaining immoveable) till through the ſights thereof you eſpy the mark at B. See what degrees on the braſs limb are cut by the index, which ſuppoſe 80; write that down in your field-book; ſo turn the index round to every one of the other angles, putting down in your field-book what degrees the index points to. As for example at C 107 degrees, at D 185: but at D, the end of the index will go off the braſs limb, and the other end will come on; you muſt therefore look for what degrees the index cuts in the innermoſt circle of the limb at the points E and F; ſuppoſe 260 and 315 degrees reſpectively.

Theſe obſervations you muſt note down in your field-book thus:

| Angles. | Degrees. Minutes. | Chains. Links. |
|---|---|---|
| ⊙ A | 060 . 00 . | 8 . 70 |
| ⊙ B | 080 . 00 . | 10 . 00 |
| ⊙ C | 107 . 00 . | 11 . 40 |
| ⊙ D | 185 . 00 . | 10 . 50 |
| ⊙ E | 260 . 00 . | 12 . 00 |
| ⊙ F | 315 . 00 . | 8 . 78 |

Secondly, cauſe the diſtance between your inſtrument and every angle to be meaſured: thus, from ⊙ to A will be found to be 8 chains 70 links; from ⊙ to B, 10 chains 00. All which ſet down in order in your field-book, as you ſee done above; and then have you got what is neceſſary to be known in that field towards meaſuring of it. Your next work is to protract or lay it down upon paper.

*To*

### *To protract the former obſervations taken.*

Firſt, draw a line at pleaſure, as A*a*; then take from your ſcale with your compaſſes, the firſt diſtance meaſured, *viz.* from ⊙ to A, 8 chains, 70 links; and ſetting one foot in any convenient place of the line, which may repreſent the place where the inſtrument ſtood, with the other make a mark upon the line as at A, ſo ſhall A be the firſt angle, and ⊙ the place where the inſtrument ſtood.

Secondly, take a protractor, and having laid the center hereof exactly upon ⊙, and the diameter or meridian upon the line A*a*, the ſemicircle of the protractor lying upwards; there hold it faſt, and with your protracting pen make a mark upon the paper againſt 80 deg. 107 deg. &c. as you find them in the field-book. Then for thoſe degrees that exceed 180, you muſt turn the protractor downward, keeping ſtill the center upon ⊙, and placing again the diameter upon *a* A. Mark out by the innermoſt circle of diviſions the reſt of your obſervations 185, 260, 315. Then applying a ſcale to ⊙ and every one of the marks, draw the dotted lines ⊙ B, ⊙ C, ⊙ D, ⊙ E, ⊙ F.

Thirdly, Take with your compaſſes the length of the line ⊙ B, which you find by the field-book to be 10 chains, which ſet off from ⊙ to B. The like to do for ⊙ C, ⊙ D, and the reſt.

Laſtly, Draw the lines AB, BC, CD, &c. which will incloſe a figure exactly proportionable to the field before ſurveyed.

### *To take the plot of the ſame field at one ſtation by the plain table.*

Place your table with a ſheet of paper upon it at ⊙, and making a mark upon the paper, that ſhall ſignify where the inſtrument ſtands, lay your index to the mark, turning it about till you ſee through the ſights the mark at A; there holding it faſt, draw the line A ⊙. Turn the index to B, keeping ſtill upon the firſt mark at ⊙; and when you ſee through the ſights the mark at B, draw the line B ⊙. Do the ſame by all the reſt of the angles, and having meaſured the diſtance between the inſtrument and each angle, ſet it off with your ſcale and compaſſes from ⊙ to A, from ⊙ to B, &c. making marks where, upon the ſeveral lines, the diſtances fall.

Laſtly, Between thoſe marks draw lines, as AB, BC, CD, *&c.* and then you have the true plot of the field ready protracted to your hand. This inſtrument is ſo plain and eaſy to be underſtood, I ſhall give no more examples of the uſe of it. The greateſt inconveniency that attends it is, that when any rain, or even dew falls, the paper will be wet, and the inſtrument uſeleſs.

### *To take the plot of the ſame field at one ſtation by the ſemicircle, either with the help of the needle and limb both together, or by the help of the needle alone.*

In the beginning of this chapter, I ſhewed you how to take the plot of a field at one ſtation, by the

the ſemicircle, without reſpect to the needle, which is the beſt way: but that I may not leave you ignorant of any thing belonging to your inſtrument, I ſhall here ſhew how to perform the ſame with the help of the needle two ways; and firſt with the needle and limb together.

Fix the inſtrument as before, in ⊙, making the north point of the needle hang directly over the *flower-de-luce* of the card; there ſcrew faſt the inſtrument. Then turn the index to all the angles, noting down what degrees are cut thereby at every angle, as at A ſuppoſe 25, at B 105, at C 132; and ſo of the reſt round the field. And when you have meaſured the diſtances, and are come to protraction, you muſt firſt draw a line croſs your paper, calling it a north and ſouth line, which repreſents the meridian line of the inſtrument. Then applying the protractor to that line, mark round the degrees as they were obſerved, *viz.* 25, 105, 132, *&c*, and having ſet off the diſtances, and drawn the outward lines agreeable to what you were taught at the beginning of the chapter, you will find the figure to be the ſame as there deſcribed.

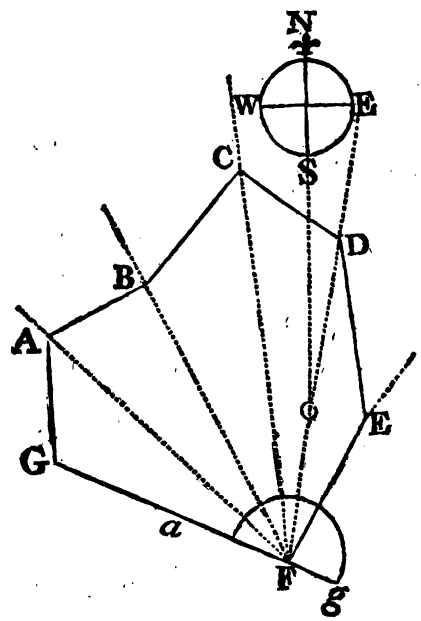
Now to perform this by the needle only is in a manner the ſame as the former: for inſtead of turning the index about the limb, and obſerving what degrees are cut thereby, here you muſt turn the whole inſtrument about, and note at every angle what degrees upon the card the needle hangs over; which ſet down and protract as before. But here obſerve, ſome cards are numbered from the north eaſtwards 10, 20, 30, *&c.* to 360 deg. others from the north weſtward, which indeed

deed are beſt for this uſe, protractors being made accordingly: for when you turn your inſtrument to the eaſtward, the needle will hang over the weſtward diviſion, on the contrary.

As for the uſe of the diviſion of the card into four quadrants, I ſhall ſpeak largely of by and by; therefore for the preſent beg your patience.

*To take the plot of a field, at one ſtation, by the ſemicircle placed in any angle thereof, from whence the other angles can be ſeen.*

Let GABCDEFG be the field, and F the angle




at which you would take your obſervations. Having placed your ſemicircle at F, turn it about the north

north point of the card from you, till through the fixed ſights, (*Note*, that I call them the fixed ſights which are on the fixed diameter) you eſpy the mark at G. Then ſcrew faſt the inſtrument; which done, move the index, till, through the ſights thereof, you ſee the mark at A, and the degrees on the limb there cut by it will be 20. Move again the index to the mark at B, where you will find it to cut 40 deg. Do the ſame at C, and it cuts 60 deg. Likewiſe at D 77, and at E 100 deg. Note down all theſe angles in your field-book: next meaſure all the lines, as from F to G 14 chains, 60 links; from F to A 18 chains, 20 links; from F to B 16 chains, 80 links; from F to C 21 chains, 20 links; from F to D 16 chains, 95 links; from F to E 8 chains, 50 links; and then will your field-book ſtand thus:

| Angles. | Degrees. | Minutes. | | Chains. | Links. |
|---|---|---|---|---|---|
| | | | F G | 14 | 60 |
| G F A | 20 | 00 | F A | 18 | 20 |
| G F B | 40 | 00 | F B | 16 | 80 |
| G F C | 60 | 00 | F C | 21 | 20 |
| G F D | 77 | 00 | F D | 16 | 95 |
| G F E | 110 | 00 | F E | 8 | 50 |

*To protract the former obſervations.*

Draw a line at adventure, as G*g*, upon any convenient place; on which lay the center of your protractor, as at F, keeping the diameter thereof right upon the line G*g*. Then make marks round the protractor at every angle, as you find them in the field-book, *viz.* againſt 20, 40, 60, 77, and 100; which

which done, take away the protractor, and applying the ſcale or ruler to F, and each of the marks, draw the lines FG, FA, FB, FC, FD, and FE. Then ſetting off upon theſe lines the true diſtances as you find them in the field-book; thus for the firſt line FG, 14 chains, 60 links; for the ſecond FA, 18 chains, 20 links, *&c.* make marks where the end of theſe diſtances fall, which let be at G, A, B, C, *&c.*

Laſtly, Between theſe marks, drawing the lines GA, AB, BC, CD, DE, EF, FG, you will have compleated the work.

When you ſurvey thus without the help of the needle, you muſt remember before you come out of the field to make the meridian line, that you may be able to make a compaſs ſhowing the true ſituation of the land, in reſpect of the four quarters of the heavens; I mean *Eaſt*, *Weſt*, *North*, and *South*: which you may do thus:

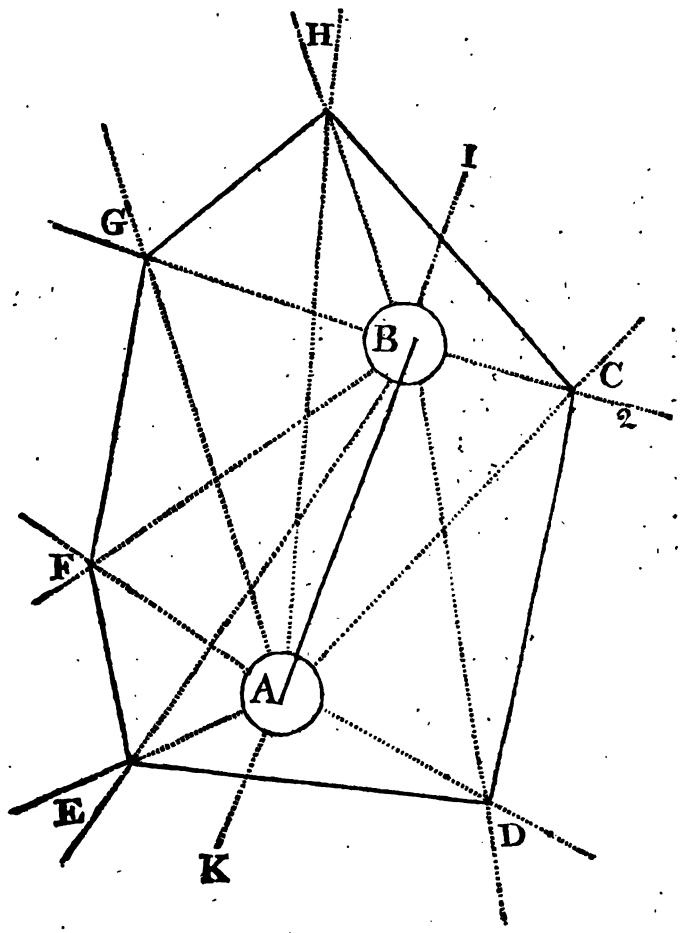
The inſtrument ſtill ſtanding at F, turn it about till the needle lies directly over the *flower-de-luce* of the card; there ſcrew it faſt. Then turn the moveable *index*, till, through the ſights, you eſpy any one angle.

As for example: Let it be D: note then what degrees upon the limb are cut by the index, which let be 10 deg. Mark this down in your field-book, and when you have protracted as before directed, lay the center of your protractor upon any place of the line FD, as at ☉, turning the protractor about till to 10 deg. lie directly upon the line FD. Then againſt the end of the diameter of the protractor, make a mark as at N, and draw the line N ☉, which is a meridian, or north or ſouth line, by which you may make a compaſs.

*Note,* You may take the plot of a field at one ſtation, by ſtanding in any ſide thereof, as well as in an angle: for if you had ſet your inſtrument in *a*, the work would have been nearly the ſame.

*To take the plot of a field at two ſtations, provided from either ſtation you can ſee every angle; by meaſuring only the ſtationary diſtance, and obſerved angles.*

Let CDEFGHC be ſuppoſed a field to be meaſured at two ſtations: firſt, when you come into the field, make choice of two places for your ſtations, as far aſunder as the field will conveniently admit of; alſo take care that if the ſtationary diſtance were continued, it would not touch any angle of the field; then ſetting the ſemicircle at A, the firſt ſtation, turn it about, the north point from you, till, through the fixed ſights, you eſpy the mark at your ſecond ſtation, which admit to be at B, there ſcrew faſt the inſtrument; then turn the moveable index to every ſeveral angle round the whole field, and ſee what degrees




degrees are cut thereby at every angle, which note down in your field-book, as followeth:

Angles,

| Angles. | Degr. | Min. | |
|---|---|---|---|
| BAC | 24 | 30 | |
| BAD | 97 | 00 | |
| E | 225 | 00 | Firſt ſtation. |
| F | 283 | 30 | |
| G | 325 | 00 | |
| H | 346 | 00 | |

Secondly, Meaſure the diſtance between the two ſtations, which let be 20 chains, and ſet it down in the field-book thus:

*Stationary diſtance* 20 *chains,* 00 *links.*

Thirdly, Placing the inſtrument at B, the ſecond ſtation, look backwards through the fixed ſights to the firſt ſtation at A, (I mean by looking backward, that the ſouth part of the inſtrument be towards A) and having eſpied the mark at A, make faſt the inſtrument, and moving the index as you did at the firſt ſtation to each angle, ſee what degrees are cut by the index, and note them down as followeth; and then have you done, unleſs you will take a meridian line before you move the inſtrument; which you were taught to do in the laſt example:

| Angles. | Degr. | Min. | |
|---|---|---|---|
| IBC | 84 | 00 | |
| IBD | 149 | 00 | |
| E | 194 | 00 | Second ſtation. |
| F | 215 | 00 | |
| G | 270 | 00 | |
| H | 322 | 00 | |

*How to protract or lay down upon paper theſe following obſervations.*

Firſt, Draw a line croſs your paper at pleaſure, as the line IK; then take off from the ſcale the ſtationary diſtance 20 chains, and ſet it upon that line, as from A to B, ſo ſhall A repreſent the firſt ſtation, B the ſecond.

Secondly, Apply the center of your protractor to the point A, and the diameter lying ſtrait upon the line BK; mark out round it the angles, as you find them in the field-book, and through thoſe marks from A draw lines of a convenient length.

Thirdly, Move your protractor to the ſecond ſtation B; and there mark out your angles, and draw lines, as before, at the firſt ſtation.

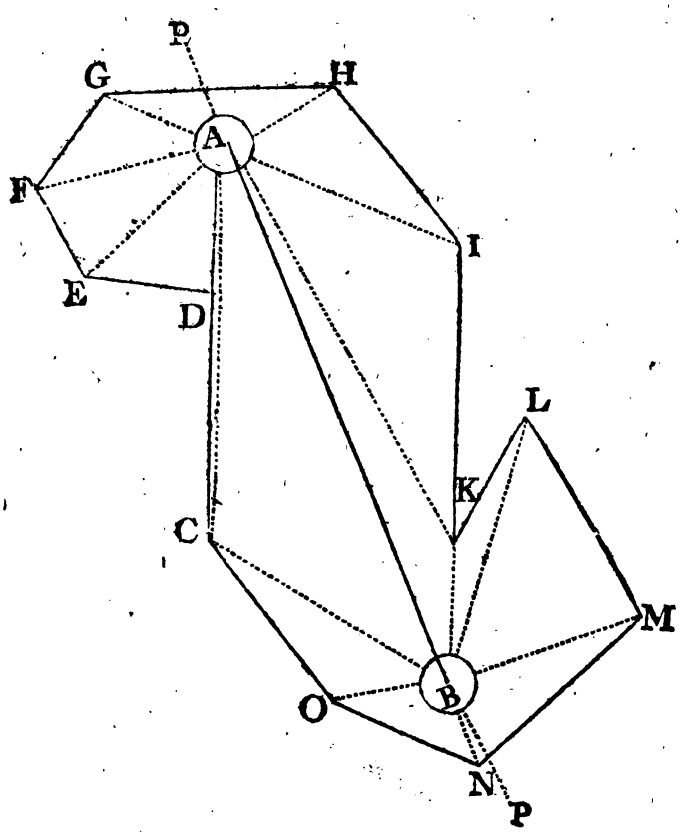
Laſtly, The places where the lines of the firſt ſtation, and the lines of the ſecond interſect each other, are the angles of the field. As for example:

At the firſt ſtation the angle C was 24 degrees 30 minutes, through thoſe degrees I draw the line AC. At the ſecond ſtation C was 84 degrees; accordingly from the ſecond ſtation I draw the line B 2: Now, I ſay, where theſe two lines cut each other, as they do at C, there is one angle of the field. So likewiſe of D, E, and the reſt of the angles; if therefore between theſe interſections you draw ſtrait lines, as CD, DE, EF, *&c.* you will have a true figure of the field.

This may as well be done by taking two angles for your ſtations, and meaſuring the line between them,

them, as C and D; from whence you might as well have ſeen all the angles, and conſequently as well have performed the work.

*To take the plot of a field at two ſtations, when the field is ſo irregular, that from one ſtation you cannot ſee all the angles.*



Let CDEFGHIKLMNOC be a field, in which from no one place thereof all the angles may be ſeen; chooſe therefore two places for your ſtations, as A and B; and ſetting the ſemicircle in A, direct the diameter to the ſecond ſtation B; there making the inſtrument faſt, with the index take all the angles at that end of the field, as CDEFGHIK, and meaſure the diſtance between your inſtrument and each angle; meaſure alſo the diſtance between the two ſtations A and B.

Secondly, Remove your inſtrument to the ſecond ſtation at B; and having made it faſt, ſo as that through the back-ſights you may ſee the firſt ſtation A, take the angle at that end of the field, as NOCKLMN, and meaſure their diſtances alſo as before; all which done, your field-book will ſtand thus:

*Firſt ſtation.*

| Angles. | Degr. | Min. | Chains. | Links. |
|---|---|---|---|---|
| CAD | 25 | 00 | 20 | 75 |
| CAE | 31 | 00 | 8 | 10 |
| CAF | 67 | 00 | 9 | 85 |
| CAG | 101 | 00 | 10 | 80 |
| H | 137 | 00 | 7 | 00 |
| I | 262 | 00 | 6 | 70 |
| K | 316 | 00 | 13 | 70 |
| C | 354 | 00 | 24 | 50 |

The diſtance between two ſtations, 31 chains, 60 links.

*Second*

*Second ſtation.*

| Angles. | Degr. | Min. | | Chains. | Links. |
|---|---|---|---|---|---|
| PBN | 3 | 30 | = | 4 | 29 |
| PBO | 111 | 00 | = | 7 | 00 |
| PBC | 145 | 00 | = | 15 | 60 |
| K | 205 | 00 | = | 7 | 48 |
| L | 220 | 00 | = | 15 | 00 |
| M | 274 | 00 | = | 11 | 20 |

To lay this down upon paper, draw at pleaſure the line PBAP; then taking in with the compaſſes the diſtance between the two ſtations, *viz.* 31 chains, 60 links; ſet it upon the line, making marks with the compaſſes, at A and B; A being the firſt ſtation, B the ſecond, lay the protractor to A, with the north end of the diameter towards B, and mark out the ſeveral angles obſerved at your firſt ſtation, drawing lines, and ſetting off the diſtances, as you were taught in the beginning of this Chapter, *Fig.* 1.

Do the ſame at B, the ſecond ſtation; and when you have traced out all the diſtances between thoſe marks, draw the bound-lines.

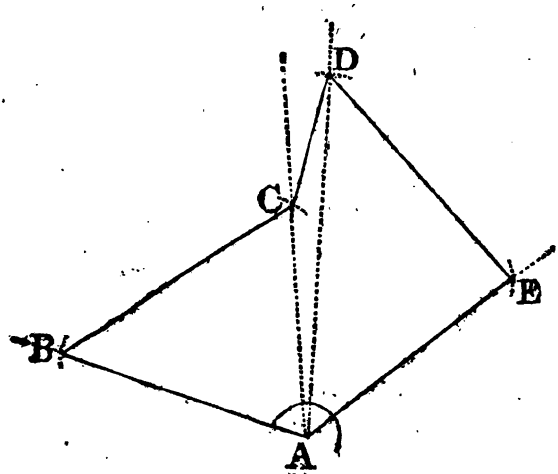
I am rather more brief in this, becauſe it is the ſame as was taught concerning *Fig.* 1; for if you conceive a line to be drawn from C to K, then would there be two diſtinct fields to be meaſured at one ſtation in each.

If a field be very irregular, you may, after the ſame manner, make three, four, or five ſtations, if you pleaſe; but I think it better to go round ſuch a field, and meaſure the bounding lines thereof; which I ſhall ſhew you how to do farther on.

*Note*, In the foregoing figure you might as well have had your ſtations in two convenient angles, as D and K, and have wrought as you were taught concerning *Fig.* 2. the work would have been the ſame.

*To take the plot of a field at one ſtation in an angle (provided from that angle you can ſee all the other angles) by meaſuring round about the ſaid field.*

ABCDEA is a field, and A the angle appointed for the ſtation; place your ſemicircle in A, and direct the diameter thereof, till, through the fixed ſights, you ſee the mark at B; then ſcrew it faſt, and turn the index to C, obſerving what degrees are there cut upon the limb; which ſuppoſe 68 degrees: turn it further, till you eſpy D, and note down the degrees there cut, *viz.* 76; do the




like

like at E, and the index will cut 124 degrees: this done meaſure round the field, noting down the length of the ſide lines between angle and angle, as from A to B, 14 chains 00 links; from B to C, 15 chains, 00 links; from C to D, 7 chains, 00 links; from D to E, 14 chains, 40 links: and from E to A, 14 chains, 5 links.

Then will your field-book be as hereunder.

| Angles. | Degr. | Min. |
|---|---|---|
| BAC— | 68 | . 00 |
| BAD— | 76 | . 00 |
| BAE— | 124 | . 00 |

| Angles. | Chains. | Links. |
|---|---|---|
| AB— | 14 | . 00 |
| BC— | 15 | . 00 |
| CD— | 7 | . 00 |
| DE— | 14 | . 40 |
| EA— | 14 | . 5 |

To protract the figure, draw the right line AB at pleaſure; and applying the center of the protractor to A, (the diameter lying upon the line AB, and the ſemicircle of it upwards) mark off the angles as 68: 76: and 124; through theſe marks draw the lines AC, AD, AE, of ſufficient length; then take in your compaſſes, from off the ſcale, the length of the line AB, *viz.* 14 chains, and ſetting one foot of the compaſſes in A, with the other croſs the line, as at B; alſo for BC take off 15 chains, and ſetting one foot in B, with the other croſs the line AC, which determines the point C; for the line CD, take off 7 chains, and ſetting one foot in C, croſs the line AD, at D; then for DE, take 14 chains, 40 links, and ſet-

ting one foot of the compaſſes in DE, with the other croſs the line AE, at E. Laſtly, take EA 14 chains 5 links in your compaſſes, and ſet one point in E; then if the other will fall exactly upon A, you have done the work true; if not, you have erred: between the points of interſection draw ſtrait lines, which ſhall be the bounds of the field, *viz.* AB, BC, CD, DE, EA.

*To take the plot of the foregoing field, by meaſuring one line only, and taking obſervations at every angle.*

Begin as you have been juſt before taught, 'till you have taken the angles BAC, BAD, and BAE, *viz.* 68, 76, and 124 degrees; then leaving a good mark at A, which may be ſeen all round the field, go to B, meaſuring as you go the diſtance from A to B, which is the only line you need meaſure; and planting your ſemicircle at B, direct the ſouth part thereof toward A, until through the back fixed ſights you ſee the mark at A; there making it faſt, turn the index about till you eſpy C, and note down the degrees there cut, which ſuppoſe 129; move your inſtrument to C, and ſtill keeping the ſouth part of the diameter to A, turn the index to D, where it will cut 20 degrees; then remove to D, and eſpying A through the back ſights, turn the index to E, where it will cut 135 degrees. Note all this down in your field-book.

*Angles*

| *Angles taken at the first ſtation.* | | *External angles round the field.* | |
|---|---|---|---|
| BAC— 68 | | B . 129 | |
| BAD— 76 | Degrees. | C . 20 | Degrees. |
| BAE—124 | | D . 235 | |

Line AB: 14 chains.

To protract this, you muſt work as you were taught concerning the foregoing figure, until you have drawn the lines AC, AD, AE, and ſet off the line AB, 14 chains; then laying the center of your protractor to B, and the ſouth end of the diameter (or that marked with 180 degrees) towards A, make a mark againſt 129 degrees, and through that mark from B, draw the line BC, till it interſect the line AC, which it will do at C. Lay alſo the center of the protractor upon C, and the diameter thereof along AC; and againſt 20 degrees make a mark, through which from C draw the line CD, till it interſect the line AD, which it will do at D. Laſtly, place your protractor at D, with the diameter thereof lying upon the line DA, and make a mark againſt 135 degrees; through this mark draw the line DE, to interſect the line AE, as at E, draw the line EA, and you have done.

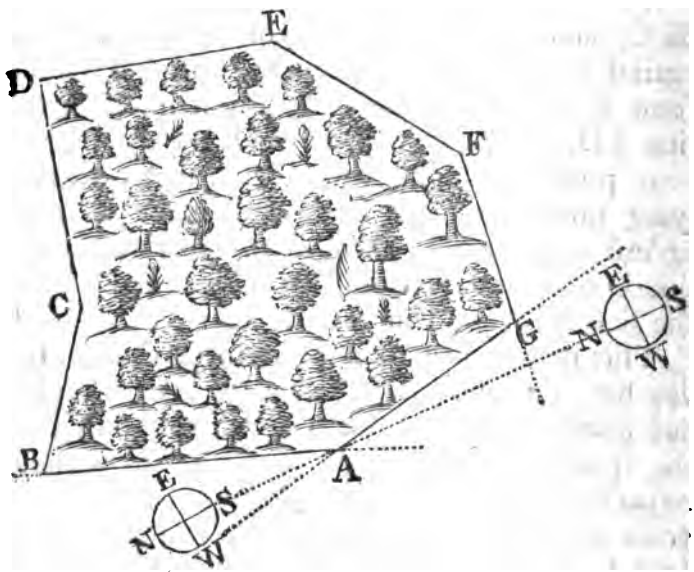
This may be otherwiſe performed, thus: after you have (ſtanding at A) taken the ſeveral angles, and meaſured the diſtance AB, you may only take the quantity of the bounding angles, without reſpect to A; as the internal angle at B 51 degrees at C (an outward angle, which in your field-book you ſhould diſtinguiſh with a mark 7) 118, and ſo of the reſt. And when you come to plot, having found the place for B, there

there make an angle of 51 degrees, drawing the line till it inſerſect A C, *&c.*

You may alſo ſurvey a field after this manner, by ſetting up a mark in the middle thereof, and meaſuring from that to any one angle; alſo in the obſervations round the field, having reſpect to that mark, as you had here to the angle A.

It is too tedious to give examples of all the varieties; beſides it would rather puzzle than inſtruct a *neophyte*.

*To take the plot of a large field or wood, by meaſuring round the ſame, and taking obſervations at every angle thereof by the ſemicircle.*




1. Suppoſe

1. Suppoſe ABCDEFGA to be a wood through which you cannot ſee to take the angles, as before directed, but muſt be forced to go round the ſame; firſt plant the ſemicircle at A, and turn the north end of the diameter about, till through the fixed ſights you ſee the mark at B; then move round the index, till through the ſights thereof you eſpy G, the index there cutting upon the limb, ſuppoſe 146 degrees.

2. Remove to B, and as you go, meaſure the diſtance AB, *viz.* 23 chains, 40 links; and planting the inſtrument at B, direct the north end of the diameter to C, and turn the index round to A, it then pointing to 76 degrees.

3. Remove to C, meaſuring the line as you go, and ſetting your inſtrument at C, direct the north end of the fixed diameter to D, and turn the index till you eſpy B, and the index then cutting 205 degrees; which, becauſe it is an outward angle, you may mark thus 7 in your field-book.

4. Remove to D, and meaſure as you go; then placing the inſtrument at D, turn the north end of the diameter to E, and the index to C, the quantity of the angle will be 84 degrees.

And thus you muſt do at every angle round the field, and at E, you will find the quantity of that angle to be 142 degrees, at F 137, at G 110: but there is no need for taking the laſt angle, or meaſuring the two laſt ſides, unleſs it be to prove the truth of your work; which is however convenient. When you have thus gone round the wood or field, you will find your field-book to be as followeth;

Angles

| Angles. | Degr. | Min. | Links. | Ch. | Link. |
|---|---|---|---|---|---|
| A | 146 | 00 | AB | 23 | 40 |
| B | 76 | 00 | BC | 15 | 20 |
| C | 205 | 00 | CD | 17 | 90 |
| D | 85 | 00 | DE | 20 | 60 |
| E | 142 | 00 | EF | 13 | 60 |
| F | 137 | 00 | GA | 19 | 28 |
| G | 110 | 00 | | | |

To protract this, draw with a black lead pencil, a line at pleaſure, as AB; upon which ſet off the diſtance, as you ſee in your field-book, 23 chains, 40 links, from A to B; then laying the center of your protractor upon A, and the diameter along the line AB, with the north end, or that of 00 degrees towards B, on the outſide of the limb make a mark againſt 146 degrees, through which from A draw the line AG; ſo you have the firſt angle and firſt diſtance.

2. Place the center of the protractor upon B, and turn it about till 76 degrees lie upon the line AB; there hold it faſt, and againſt the north end of the diameter make a mark, through which draw a line, and ſet off the diſtance BC, 15 chains, 20 links.

3. Apply the center of the protractor to C, (the ſemicircle thereof outward, becauſe you ſee by the field-book it is an outward angle) and turn it about till 205 degrees lie upon the line CB; then againſt the upper or ſouth end of the diameter make a mark, through which draw a line, and ſet off 17 chains, 90 links from C to D.

4. Put

4. Put the center of the protractor to D, and make 84 degrees thereof lie upon the line CD; then making a mark at the end of the diameter, or 0 *degr.* through that mark draw a line, and ſet off 20 chains, 60 links for DE.

5. Move the protractor to E, and make 142 *degr.* to lie upon the line ED. Then at the end of the protractor make a mark as before, and ſetting off the diſtance 18 chains, 85 links, draw the line EF.

6. Lay the center of the protractor upon F, and making 137 *degr.* lie upon the line EF; againſt the end of the diameter make a mark, through which draw the line FG, which will interſect the line AG as at G: ſo you have a true copy of the field or wood. But you may, if you think fit to prove your work, ſet off the diſtance from F to G; and at G apply your protractor, making 110 *degr.* thereof to lie upon the line FG. Then if the end of the diameter point directly to A, and the diſtance be 90 chains, 28 links, you may be ſure you have done your work true.

Whereas I bid you put the north end of the inſtrument and of the protractor towards B, it was chiefly to ſhew you the variety of working by one inſtrument; for in the figure before this, I directed you to do it the contrary way; and in this figure, if you had turned the ſouth end of the inſtrument to G, and with the index had taken B, and ſo of the reſt, the work would have been the ſame; remembering ſtill to uſe the protractor the ſame way as you did your inſtrument in the field.

Alſo if you had been to have ſurveyed this field or wood by the help of the needle; after you had planted the ſemicircle at A, and poſited it, ſo that the

the needle might hang directly over the *flower-de-luce* in the card, you ſhould have turned the index to B, and put down in your field-book what degrees upon the braſs limb had then been cut thereby, which, for example, ſuppoſe 20. Then moving your inſtrument to B, make the needle hang over the *flower-de-luce*, and turn the index to C, and note down what degrees are there cut. So do by all the reſt of the angles. And when you come to protract, you muſt draw lines parallel to one another croſs the paper, not farther diſtant than the breadth of the parallelogram of your protractor; which ſhall be meridian lines, marking one of them at one end N. for the north, and at the other S. for ſouth. This done chooſe any place which you ſhall think moſt convenient upon one of the meridian lines for your firſt angular point, as at A; and laying the diameter of your protractor upon that line, againſt 20 *degr.* make a mark; through which draw a line, and upon it ſet off the diſtance from A to B.

In like manner proceed with the other angles and lines, at every angle laying your protractor parallel to a north and ſouth line; which you may do by the figures graduated thereon, being at either end alike.

*When you have ſurveyed after this manner, to diſcover before you go out of the field, whether you have wrought true or not.*

Add all the obſerved angles together in the preceding example of meaſuring the wood, they make 900. Multiply 180 by a number leſs by two than the

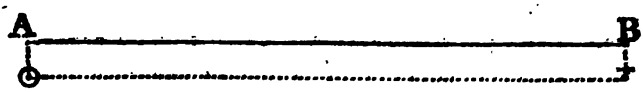
the number of angles; and if the product be equal to the ſum of all the angles, then you have wrought true. There were ſeven angles to that wood, therefore multiply 180 by 5, and the product is 900.

If you ſurvey, by taking the quantity of every angle, and if all be inward angles, you muſt work as before. But if one or more be outward angles, you muſt ſubtract them out of 180 *degr.* and add the remainder only to the reſt of the angles. And when you multiply 180 by a ſum leſs by 2 than the number of your angles, you are not to account the outward angles into the number. Thus, in the laſt examples, I find one outward angle, *viz.* C 205; the quantity of which, if it had been taken, would have been but 155 *degr.* That taken from 180 *degr.* there remains 25; which I add to the other angles, and they make in all 720. Now becauſe C was an outward angle, I take no notice of it, but ſee how many other angles I have, and I find 6: a number leſs by two than 6, is 4: by which I multiply 180, and the product is 720, and conſequently the work is right.

*Directions to meaſure parallel to a hedge, (when you cannot go into the hedge itſelf;) and alſo, in ſuch caſe, how to take your angles.*

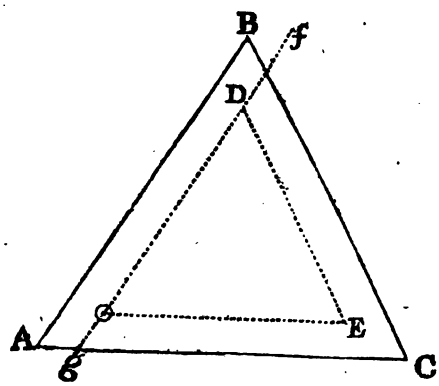
It is impoſſible for you, when you have a hedge to meaſure, to go on the top of the hedge itſelf; but if you go parallel thereto, either within or without, and make your parallel line of the ſame length as the line of your hedge, your work will be the ſame.

ſame. Thus, if AB was a buſhy hedge, to which




you could not conveniently come nigher to plant your inſtrument than ⊙; let him that goes to ſet up your mark at B, take before he goes the diſtance A ⊙, which he may do readily with a wand or rod; and at B let him ſet off the ſame diſtance again, as to +, where let the mark be placed for your obſervation; and when the chain bears, meaſure the diſtance ⊙+; be ſure they have reſpect to the hedge AB, ſo as that they make ⊙+ equal to AB, or of the ſame length.

But to make this more plain: ſuppoſe ABC to be a field; and for the buſhes, you cannot come nigher than ⊙ to plant your inſtrument. Let him

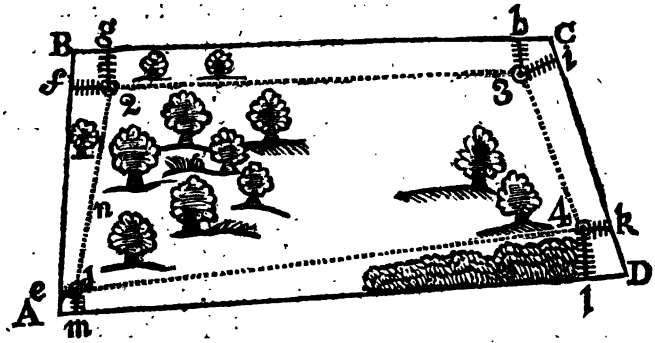



that ſets up the marks take the diſtance between the inſtrument ⊙, and the hedge AB; which diſtance let him ſet off again nigh B, and ſet up his mark at D; like-

likewiſe let him take the diſtance between the ⊙ and the hedge AC, and accordingly ſet up his mark at E. Then taking the angle D ⊙ E, it will be the ſame as the angle BAC: ſo do for the reſt of the angles. But when the lines are meaſured, they muſt be meaſured of the ſame length as the outſide lines, as the line ⊙ D meaſured from *g* to *f*, *&c.* The beſt way, therefore, is for thoſe who meaſure the lines, to go round the field on the outſide thereof, although the angles be taken within.

*To take the plot of a field or wood, by obſerving near every angle, and meaſuring the diſtance between the marks of obſervation, by taking in every line, two off-ſets to the hedge.*

Let A, B, C, D, be a wood or field, to be thus meaſured. Cauſe your aſſiſtants to ſet up marks




in every angle thereof, not regarding the diſtance from the hedges, ſo much as the convenience for planting the inſtrument, ſo as you may ſee from

one mark to another. Then beginning at ⊙ 1, take the quantity of that angle, and meaſure the diſtance 1, 2. But before you begin to meaſure the line, take the off-ſet to the hedge, *viz.* the diſtance ⊙ *e*; and in taking of it, you muſt make that little line ⊙ *e* perpendicular to 1, 2; which is eaſily done, when your inſtrument ſtands with the fixed ſights towards 2, by turning the moveable index till it lie upon 90 *degr.* which will then direct to what place of the hedge to meaſure, as *e*, that little line ⊙ *e*, ſet down in your field-book under title *Off-ſet*. So likewiſe when you come to 2, meaſure there the off-ſet again, *viz.* ⊙ *f*. Then taking the angle at 2, meaſure the line 2, 3, and the off-ſets 2 *g*, 3 *b*. The like do by all the reſt of the lines and angles in the field. And when you come to lay theſe down upon paper; firſt, as you have been taught before, protract the figures 1, 2, 3, 4. That done, ſet off your off-ſets as you find them in the field-book, *viz.* ⊙ *e*, and ⊙ *f*, perpendicular to the line 1, 2; alſo ⊙ *g*, ⊙ *b*, perpendicular to the line 2, 3, making marks at *e*, *f*, *g*, *b*, and the reſt; through which draw lines interſecting each other at the true angular points, and then deſcribe the bound lines of the field or wood.

In working after this manner, obſerve theſe two things: firſt, if the wood be ſo thick, that you cannot go on in the inſide thereof, you may, after the ſame manner, as well perform the work by going on the outſide round the wood.

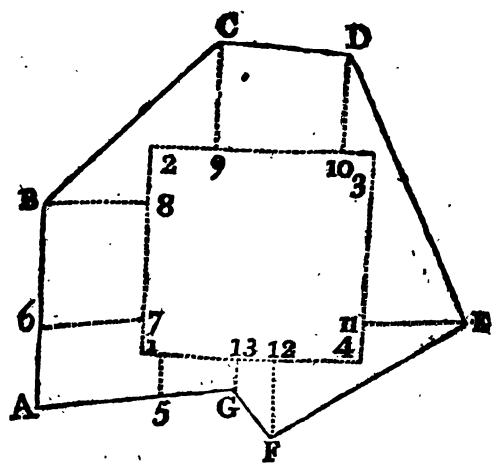
Secondly, If the diſtances are ſo great, that you cannot ſee from angle to angle, cauſe your aſſiſtant

to

to ſet up a mark as far from you as you can conveniently ſee it, as at *n*. Meaſure the diſtance ☉ 1 *n*, and take the off-ſet from *n* to the hedge. Then at *n* turn the fixed ſights of the inſtrument to ☉ 1, and by that direction proceed on the line till you come to an angle.

*This way of ſurveying is made eaſier (though I cannot ſay truer) by taking only a great ſquare in the field, from the ſides of which the off-ſets are taken.*

I have drawn this following figure ſo, that at once you may ſee all the variety of this way of working. The beſt way, indeed, is to contrive




your ſquare ſo, that if poſſible, you may, from the ſides thereof, go upon a perpendicular line to any of the angles. But if that cannot be, then per-

pendicular lines to the ſides may do as well, as you ſee here, 15 and 76 are. To begin, therefore, plant your ſemicircle in any convenient part of the field, as at 1, for taking a large ſquare; and laying the moveable index upon 90 *degr.* look through the ſights, and cauſe a mark to be ſet up in that line, as at 4: looking alſo through the fixed ſights, cauſe another mark to be ſet up, as at 2. Meaſure out from your inſtrument towards either of theſe marks, any number of chains, as 12 from 1 to 2; from 2 to 4, 12 chains. But as you meaſure, remember to take the off-ſets in a perpendicular line to every angle or ſide, if there be occaſion, as here 17, which is 1 chain, 50 links; from my ſtations I take an off-ſet to a ſide of the hedge, as 76, and put it down accordingly 5 chains, 40 links. So at 8 I take an off-ſet to an angle, *viz.* 8 B, 6 chains; which off-ſet is at the end of 8 chains, 30 links in my firſt line. Then ſeeing in that line there is no farther occaſion for off-ſets, I plant my inſtrument at 2, and I direct the fixed ſights to my firſt ſtation; then laying the index upon 90 *degr.* I cauſe a mark to be ſet up, ſo that I may ſee it through the ſights; and in that direction I meaſure out 2 chains, taking the off-ſets C 9, D 10, proceed in like manner for the other angles, lines, and off-ſets.

When you have thus laid out your ſquare, and taken all your off-ſets, you will find in your field-book ſuch *memorandums* as the following, to help you to protract.

*The angles* 4 *right angles.*
*The ſides* 12 *chains,* 00 *links each.*

I went round *cum ſolis*, or the hedges being on my left-hand.

| | C. | L. | | C. | L. |
|---|---|---|---|---|---|
| In the firſt line, at | 1 | 50 | Off-ſet to a ſide-line | 5 | 40 |
| | 8 | 30 | Off-ſet to an angle | 6 | 00 |

| | C. | L. | | C. | L. |
|---|---|---|---|---|---|
| In the ſecond line, at | 3 | 50 | Off-ſet to an angle | 6 | 00 |
| | 10 | 70 | Off-ſet to an angle | 5 | 50 |

| | C. | L. | | C. | L. |
|---|---|---|---|---|---|
| In the third line, at | 10 | 00 | Off-ſet to an angle | 5 | 30 |

| | C. | L. | | C. | L. |
|---|---|---|---|---|---|
| In the fourth line, at | 4 | 33 | Off-ſet to an angle | 4 | 40 |
| | 6 | 70 | Off-ſet to an angle | 1 | 50 |
| | 10 | 80 | Off-ſet to a ſide | 2 | 20 |

Now to lay down upon paper the foregoing work, make firſt a ſquare figure, as 1, 2, 3, 4, whoſe ſide may be 12 chains. Then conſidering you went with the ſun, take 1, 2 for the firſt line; and taking from your ſcale 1 chain, 50 links, ſet it upon the line from 1 to 7; at 7 raiſe a perpendicular, as 7, 6, making it according to your field-book, 5 chains, 40 links long. Alſo for the ſecond off-ſet upon the ſame line, take from your

ſcale of equal parts 8 chains, 30 links, which ſet upon the line from 1 to 8, and upon 8 make the perpendicular line 8 B, 6 chains in length.

For the off-ſets of the ſecond line, take 3 chains 50 links from the ſcale, and ſet it from 2 to 9; at 9 make a perpendicular line 6 chains long, *viz.* 9 C: alſo for the ſecond off-ſet of the ſame line, take 10 chains, 70 links, and ſet it from 2 to 10; at 10 make the perpendicular 10 D, 5 chains, 50 links in length.

For the off-ſets of the third line, take from your ſcale 10 chains, and ſet it up from 3 to 11; and at 11 make the perpendicular 11 E, 5 chains, 30 links long.

For the off-ſets of the fourth line, take from your ſcale 4 chains, 30 links, and ſet it from 4 to 12; and at 12 make the perpendicular 12 F, 4 chains, 40 links long. Alſo take 6 chains, 70 links, and ſet it from 4 to 13; and at 13 make the perpendicular 13 G, 1 chain, 50 links long.

*Laſtly*, Take 10 chains, 80 links, and ſet it from 4 to 1; and at 1, make the perpendicular 1, 5, 2 chains 20 links long.

Then have you no more to do, but through the ends of theſe perpendiculars to draw the bounding-lines, remembering to make angles where the field-book mentions angles; and where it mentions ſide-lines, there to continue ſuch ſide-lines till they meet in an angle.

Although I mention a ſquare, yet you are not obliged to take that figure; for you may with the ſame ſucceſs uſe a parallelogram, triangle, or any other figure. Nor are you bound to take the off-

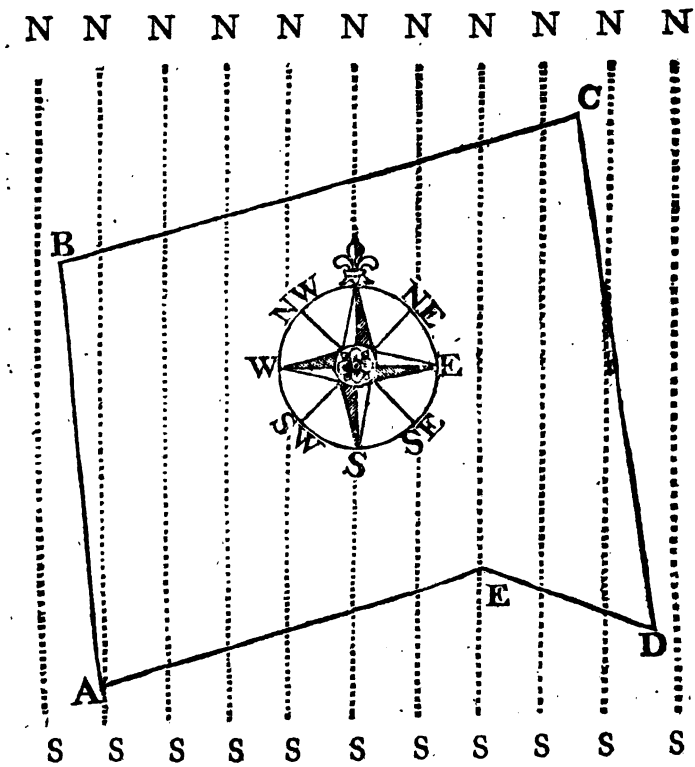
ſets

ſets in perpendicular lines, notwithſtanding it is the beſt way; for you may take the angles with the index from any part of the line.

This way was chiefly intended for ſuch as were not provided with proper inſtruments; for with the croſs ſtaff only, you may lay out a ſquare, the reſt of the work being done with a chain.

*By the help of the needle to take the plot of a large wood; by going round the ſame, and making uſe of that diviſion of the card that is numbered with four* 90° *or quadrants.*

Let ABCDEA repreſent a wood; ſet your inſtrument at A, and turn it about, till through the fixed ſights you eſpy B, then obſerve what degrees in the diviſion before ſpoken of, the needle cuts; which ſuppoſe 7 degrees from N. towards Weſt, meaſure AB 28 chains, 20 links; then ſetting the inſtrument at B, direct the ſights to C, and ſee what the needle cuts, which let be 74 degrees from N. towards the E; meaſure BC 39 chains, 50 links; in like manner meaſure every line, and take every angle, and then your field-book will ſtand thus, as followeth here under.




| Lines. | | Degrees. | Minutes. | Chains. | Links. |
|---|---|---|---|---|---|
| A B | NW | 7 | 00 | 28 | 20 |
| B C | N E | 74 | 00 | 39 | 50 |
| C D | S E | 9 | 00 | 38 | 00 |
| D E | NW | 63 | 20 | 14 | 55 |
| E A | S W | 74 | 80 | 28 | 60 |

(to the)

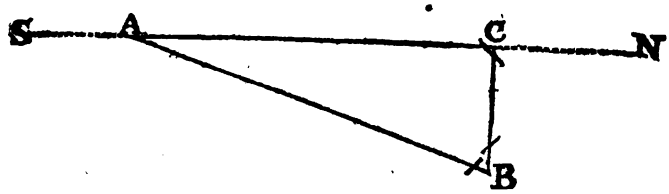
To

To lay down which upon paper, draw parallel lines, as N. S. N. S. *&c.* to repreſent meridians, or north and ſouth lines, then applying the protractor (which ſhould be graduated accordingly with twice 90 degrees, beginning at each end of the diameter, and meeting in the middle of the arch) to any convenient place of one of the lines as to A, lay the meridian line of the protractor to the meridian line on the paper, and againſt 7 *degr.* make a mark, through which draw a line, and ſet off thereon the diſtance A B 28 chains 20 links. *Secondly*, Apply the center to the protractor to B, and (turning the ſemicircle thereof the other way, becauſe you ſee the courſe tends to the eaſtward) make the diameter thereof lie parallel to the meridian lines on the paper (which you may do by the figures at the ends of the parallelogram) and againſt 74 degrees make a mark, and ſet off 39 chains, 50 links, and draw the line B C; the like do by the other lines and angles, until you come round to the place where you began.

This is the general method of plotting obſervations, taken after this manner, uſed by moſt ſurveyors in *America*, where they lay out very large tracts of land: but there is another way much ſurer, yet rather tedious, (I think firſt made public by Mr. *Norwood*) whereby you may know before you come out of the field, whether you have taken your angles, and meaſured the lines truly or not, and is as follows:

When you have ſurveyed the ground as above directed, and find your field-book to ſtand as before, caſting up what northing, ſouthing, eaſting, or weſting

ing every line makes; that is to ſay, how far at the end of every line you have altered your meridian, and what diſtance upon a meridian line you have made. As for example: ſuppoſe AB, equal to 20 chains, was the ſide of a field, NS a meridian line, the angle




CAB north 20 *degr.* eaſt. The buſineſs is to find the length of the line AC, which is called the northing, or the difference of latitude; alſo the length of the line CB, which is called the eaſting, or difference of longitude; which you may do indifferently true, by laying them down upon paper. By help of the *Gunter*'s ſcale, the beſt way is by the tables of ſines and logarithms, uſing this proportion:

As radius or ſine of 90 degrees, *viz.* the right angle C is to the logarithm of the line AB 20 chains;

So is the ſine of the angle CAB 20 degrees to the difference of longitude CB 6 chains 80 links.

Secondly, To find the difference of latitudes, or the line AC, ſay,

As radius is to the logarithm of the line AB 20 chains, ſo is the ſine complement of the angle at A, to the logarithm of the line AC 18 chains, 80 links.

EXAMPLE.

## EXAMPLE.

I find by my field-book, the firſt line (ſee the laſt figure but one) runs N.W. 7 degrees, 28 chains, 20 links; now to find what northing, and what weſting is hereby made, I ſay thus:

| | |
|---|---|
| As radius | 10,000000 |
| Is to the logarithm of the line 28 chains, 20 links | 1,450249 |
| So is the ſine of the angle from the meridian, *viz.* 7 degrees, | 9,085894 |
| To the logarithm of the weſting 3 chains, 43 links, | 10,536143 |

Again,

| | |
|---|---|
| As radius, | 10,000000 |
| Is to the logarithm 28 chains, 20 links | 1,450249 |
| So is the ſine complement of 7 degrees | 9,996751 |
| To the logarithms of the northing 27 chains, 99 links, | 11,447000 |

And having thus found the northing and weſting of that line, I put it down in the field-book againſt the line under the proper titles N. W. in like manner I find the latitude and longitude of all the reſt; and having ſet them down, the field-book will appear thus:

Lines.

| Lines. | Degrees. | Minutes. | Chains. | Links. | N | S | E | W |
|---|---|---|---|---|---|---|---|---|
| A B : NW | 7 : 00 | 28 : 20 | 27 : 99 | .. : .. | .. : .. | 05 : 43 |
| B C : N E | 74 : 00 | 39 : 50 | 10 : 86 | .. : .. | 37 : 97 | .. : .. |
| C D : S E | 9 : 00 | 38 : 00 | .. : .. | 37 : 53 | 05 : 99 | .. : .. |
| D E : NW | 63 : 00 | 14 : 55 | 06 : 53 | .. : .. | .. : .. | 13 : 00 |
| E A : S W | 74 : 00 | 28 : 60 | .. : .. | 07 : 88 | .. : .. | 27 : 49 |
| | | | | | 45 : 41 | 45 : 41 | 43 : 02 | 43 : 92 |

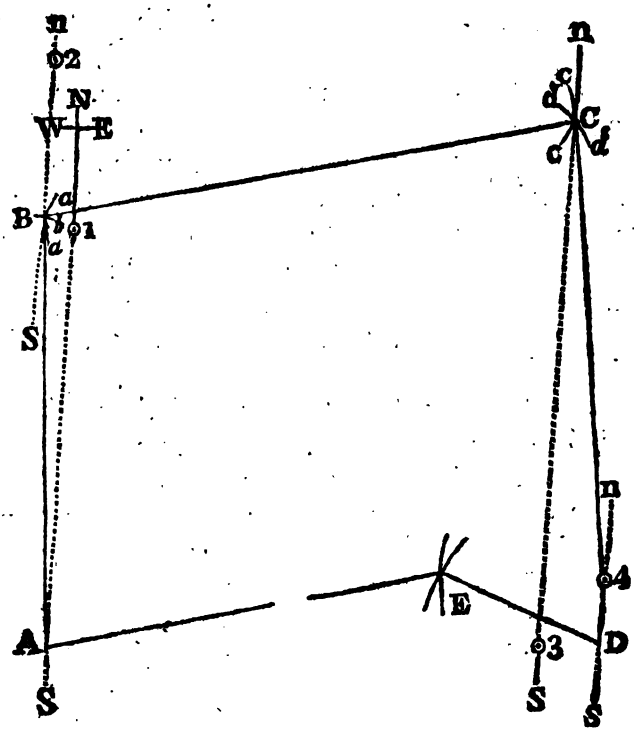
This done, add the northings together, alſo all the ſouthings, and ſee if they agree; alſo all the eaſtings and weſtings; and if they agree likewiſe, then you may be ſure you have wrought truly, otherwiſe not. Thus in the example the ſum of the northings is 45 chains, 41 links; ſo likewiſe is the ſum of the ſouthings; alſo the ſum of the eaſtings is 43 chains, 92 links, ſo is the ſum of the weſtings: therefore I ſay I have ſurveyed that piece of land true.

But becauſe this way of caſting up the northing, ſouthing, eaſting, and weſting of every line, may ſeem tedious and troubleſome, I have at the end of this book added a table, wherein, by inſpection, you may find the longitude and latitude of every line, according to the angle which it makes with the meridian.

Another way of plotting the foregoing piece of ground according to the table in the field-book, with regard to the points of the compaſs, N. S. E. and W. is as follows:

Draw

Draw an indefinite right line, as *n* ⊙ A S for a meridian line; then beginning in any place of that




line as from A to ⊙ 1, *viz.* 27 chains, 99 links; then taking with your compaſſes the weſtings of the ſame line, *viz.* 3 chains, 43 links; ſet one foot in ⊙ 1, and with the other deſcribe the arch *a a*; next take the length of your firſt line, as you find it in the field-book, *viz.* 28 chains, 20 links, and ſetting one foot of the compaſſes in A, with

with the other croſs the former arch *a a* with another arch B *b*, and in B the interſection of theſe arches is your ſecond angle. Then through B draw another north and ſouth line, as NBS, parallel to the firſt, NAS; then take with your compaſſes the northing of the ſecond line, *viz.* 10 chains 89 links, and ſet it upon that line, from B to ⊙ 2; take alſo the eaſting of the ſame line, *viz.* 37 chains, 97 links; and ſetting one foot of the compaſſes in ⊙ 2, with the other ſweep the arch *c c*; alſo take with your compaſſes the length of the ſecond line, *viz.* 39 chains 50 links; and ſetting one foot in B, croſs the former arch with another *d d*; the interſection C is your third angle.

It would be needleſs to go round thus with all the lines; for by theſe already drawn, you may eaſily conceive how all the reſt may be done. But obſerve when you ſweep the arches for the eaſting and weſting, to turn your compaſſes the right way, and not take eaſt for weſt, and weſt for eaſt.

Nor can I much recommend this way of plotting, the former being as true, and far eaſier; yet when you plot by the former way, it will be proper to prove your work by the table of difference of latitude and longitude, before you begin to protract; and when you find your field-book correct, you may lay down your work upon paper, by that method you think the eaſieſt.

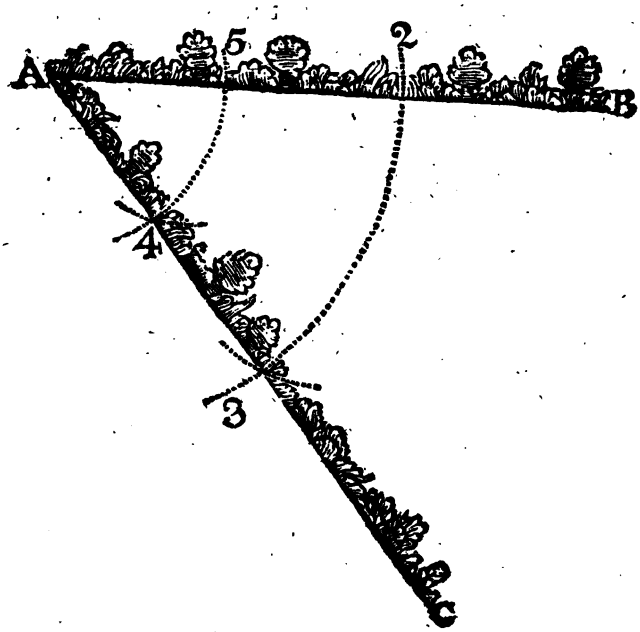
To conclude this chapter or ſection, I ſhall in the next place ſhew you, how to ſurvey a field by the chain only, uſing no other inſtrument, and that after a better manner than hitherto has been taught.

First,

Firſt, therefore, I ſhall ſhew you how to take the quantity of an angle by the chain; (which being well underſtood) there will be no more required; for the buſineſs of a ſurveyor in the field, is no more than to meaſure ſides and take angles, in order to find how many acres any field or piece of land contains.

*To take an angle in the field by help of the chain only.*

Firſt meaſure along the hedge AB, any ſmall diſtance, as two chains from A to 2; alſo meaſure




along

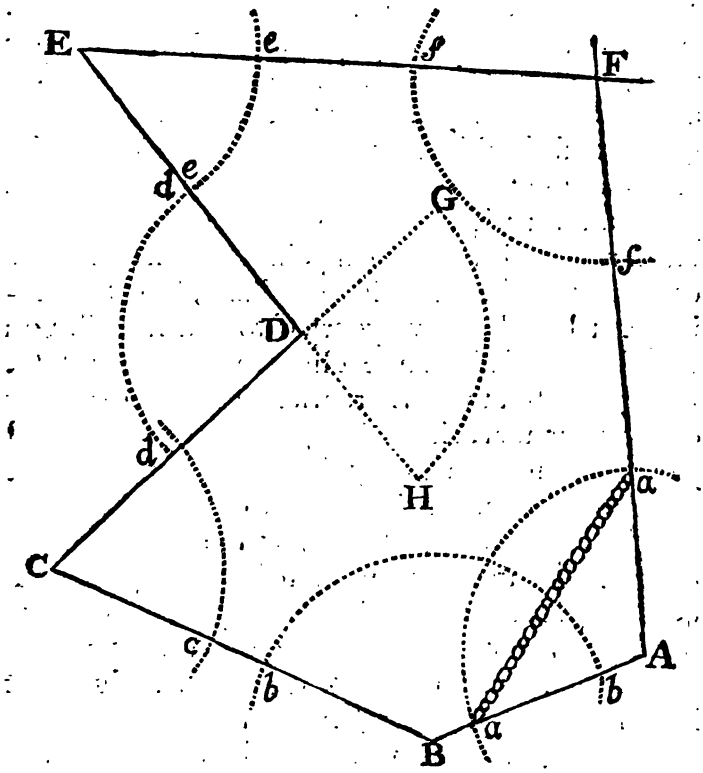
along the hedge AC any number of chains you pleaſe, (either equal to the former or not) as A 3 two chains; next meaſure the diſtance 2, 3, equal to 1 chain, 68 links; and then have you done in the field. To plot which draw the line AB at pleaſure, and ſet off 2 chains from A to 2; then take with your compaſſes the diſtance A 3, *viz.* 2 chains, and ſetting one foot in A, deſcribe the arch 2 3; take alſo with your compaſſes the diſtance 2 3, *viz.* 1 chain, 68 links; and ſetting one foot in 2, with the other croſs the former arch in A, draw the line A 4 3 C; which with AB, will make an angle equal to the angle in the field.

A more eaſy and ſpeedy way is to meaſure out one chain along the hedges thus; I ſet a ſtrong ſtick in the angle A, and putting the ring which is at one end of the chain over it, I take the other end in my hand, and ſtretch out the chain along the firſt hedge AB, and where it ends, as at 5, I ſtick down a ſtick; then I ſtretch the chain alſo along the other hedge AC, and at the end thereof ſet another ſtick as at 4; then looſing my chain from A, I meaſure the diſtance 4, 5, and find it 74 links, which is all I need note down in my field-book for that angle, and now coming to plot it, I firſt take from my ſcale the diſtance of one chain, and placing one foot of the compaſſes in any part of the paper, as at A, I deſcribe the arch 4, 5; then I take from the ſame ſcale 74 links, and ſet it off upon that arch, making marks where the ends of the compaſſes fall, as at 4 and 5. *Laſtly*, From A; through theſe marks I draw the lines AB, and AC, which conſtitute the former angle: always plot your angles with

with a very large ſcale: but your lines may be ſet off with a ſmaller.

I ſhall give you two *Examples* of this way of meaſuring, and then leave you to your own practice. Firſt,

*To ſurvey a field with the chain only, by going round the inſide of it.*




Let ABCDEFA be the field; and beginning at the angle A in that point, ſtick down a ſtaff through

the great ring at one of the ends of your chain, and taking the other end in your hand, ſtretch out the chain in length, and ſee in what part of the hedge AF, the other ends falls; as ſuppoſe at *a*, there ſet up a ſtick; and do the like by the hedge AB, and let the chain end at (*a*) alſo: meaſure the neareſt diſtance between *a* and *a*, which admit to be 1 chain 60 links: this note down in your field-book: meaſure next the length of the hedge AB, 12 chains, 50 links; note this down alſo in your field-book. Next, coming to B, take that angle in like manner as you did the angle A, and meaſure the diſtance BC: after this manner you muſt take all the angles, and meaſure all the ſides round the field. But leſt you be at a nonplus at D, becauſe it is an inward angle, thus you muſt do: ſtick a ſtaff down with the ring of the chain round it in the angular point D, then taking the other end of the chain in your hand, and ſtretching it at length, move yourſelf to and fro, till you perceive yourſelf in a direct line with the hedge DC, which will be at G; where ſtick down an arrow, or one of your ſurveying-ſticks, then move round till you find yourſelf in a direct line with the hedge DE; and there the chain being ſtill ſtretched out to its full length, plant another ſtick, as at H; then meaſure the neareſt diſtance, from H to G, which let be 1 chain, 43 links; and note it down in your field-book; proceed on to meaſure the line DE; but in your field-book make ſome mark againſt D, to ſignify it is an inward angle, as 7, or the like. And when you come to plot this, you muſt plot the ſame angle outward that you took inward; for the angle GDH is the ſame as the angle *d D d*. If you ſurvey a wood,

wood, by going round it on the outside, then the angle *d* D *d* is an outward angle.

Having thus taken all the angles and measured all the sides; the next thing to be done, is to lay them down upon paper, according to your field-book; which you will find to stand thus:

| Cross Lines or Chords. | | | Lines of the Field. | Chains. | Links. |
|---|---|---|---|---|---|
| Distance from the angular points. | Chains. | Links. | | | |
| *a a* | 1 | 60 | A B | 12 | 50 |
| *b b* | 1 | 84 | B C | 23 | 37 |
| *c c* | 1 | 06 | C D | 19 | 30 |
| *d d* | 1 | 437 | D E | 20 | 00 |
| *e e* | 0 | 80 | E F | 29 | 00 |
| *f f* | 1 | 52 | F A | 31 | 50 |

It being more convenient that the angles should be made by a greater scale than the lines are laid down with; I have therefore in this figure, made the angles by a scale of one chain in an inch, and laid down the lines by a scale of ten chains in one inch. Now to begin to plot, take from your large scale one chain; with that distance, in any convenient place of your paper, as at A, sweep the arch *a a*; then from the same scale take off 1 chain, 60 links, and set it upon that arch, as from *a* to *a*, and draw through the point, *a* and *a*, the right lines A B,

AF: then repairing to your ſhorter ſcale, take from thence the firſt diſtance, *viz.* 12 chains, 50 links; and ſetting it from A to B, draw the line AB.

Secondly, Repairing to B, take from your large ſcale one chain, and ſetting one foot of the compaſſes in B, with the other deſcribe the arch *b b*; alſo from the ſame ſcale take your chord line, *viz.* 1 chain, 84 links, and ſet it upon the arch *b b*; having one foot of the compaſſes in the point where the arch interſects AB, the other will fall at *b*; then through *b* draw the line BC; and from your ſmaller ſcale ſet off the diſtance 23 chains, 37 links, from B to C, where the next angle muſt be made. After this manner proceed on according to your field-book, till you have done.

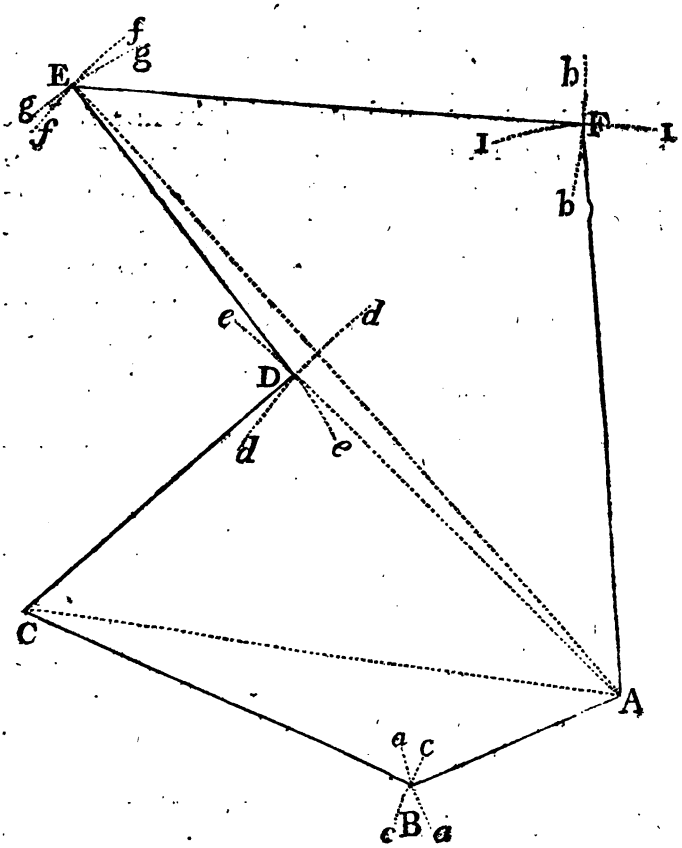
And here note, That you need neither in the field, nor in plotting upon the paper, take any notice of the angle F, nor yet meaſure the lines EF or AF; for thoſe two lines being drawn, will interſect each other at the true angular point F: however for proof of the work, it is proper to meaſure them, and likewiſe to take the angle in the field.

I muſt not omit in this place to ſhew you the uſual way taught by ſurveyors for meaſuring a field by the chain only: as true indeed as the former, but more tedious, which is as follows:

*The common way taught by ſurveyors for taking the plot of the foregoing, or any other field.*

In order that you may not be confuſed with too many lines in one figure, I have here again placed the

the ſame. Firſt, Meaſure round the field, and note down in your field-book every line thereof, as in this field has been before done.




Secondly, Divide the whole field into triangles, by drawing the diagonals AC, AD, AE, and note them down in your field-book, thus:

| | Chains. | Links. |
|---|---|---|
| AC | 33 | 70 |
| AD | 25 | 70 |
| AE | 45 | 40 |

To plot which, firſt draw a right line AC at pleaſure, and ſet off thereon 33 chains, 70 links, according to your field-book, for the firſt diagonal; then taking with your compaſſes the length of the line AB, *viz.* 12 chains, 50 links, ſet one foot in A, and with the other deſcribe the arch *a a*; alſo take the line BC, *viz.* 23 chains, 37 links, and ſetting one foot in C, with the other deſcribe the arch *c c*, cutting the arch *a a* in the point B; then draw the lines AB, CB, which ſhall be the two bound-lines of the field.

Secondly, Take with your compaſſes the length of the diagonal AD, *viz.* 25 chains 70 links, and ſetting one foot of the compaſſes in A, with the other deſcribe the arch *d d*; alſo taking the line CD, *viz.* 19 chains, 30 links, ſet one foot in C, and with the other deſcribe the arch *e e*, cutting the arch *d d* in the point D, to this interſection draw the line CD.

Thirdly, Take with your compaſſes the length of the diagonal AE, *viz.* 45 chains, 40 links; and ſetting one foot in A, with the other deſcribe an arch, as *f f*; alſo take the line DE, 20 chains, and therewith croſs the former arch in the point E, and draw the line DE.

Laſtly,

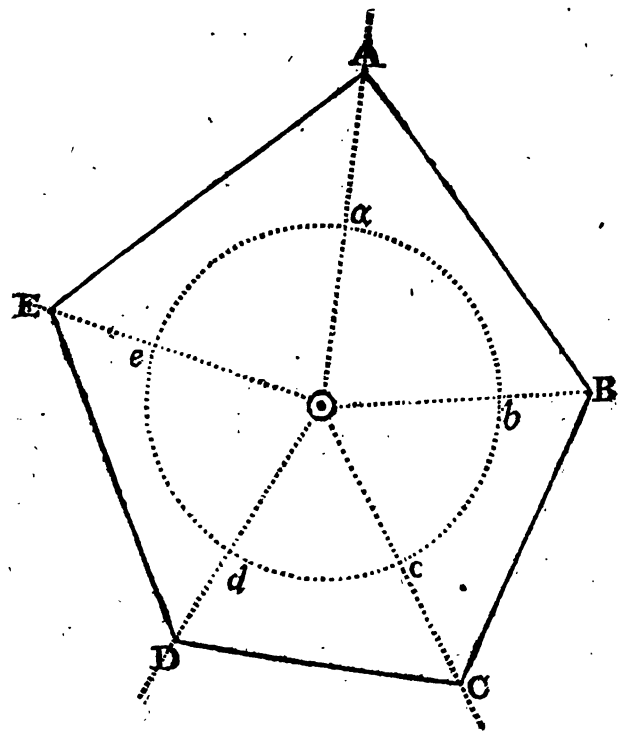
Laſtly, Take with your compaſſes the length of the line A F, *viz.* 31 chains, 50 links; and ſetting one foot in A, deſcribe an arch, as II. Alſo take the length of the line E F, *viz.* 29 chains, 00 links; and therewith deſcribe the arch *b b*, to cut the arch II in the point F; draw the lines A F and E F, and ſo will you have a true figure of the field.

I have ſhewed you both ways, that you may take your choice. And now I proceed to my ſecond example promiſed.

## *To take the plot of a field at one ſtation, near the middle thereof, by the chain only.*

Let A B C D E A be the field, ⊙ the appointed place, from whence by the chain to take the plot thereof. Stick a ſtake down at ⊙ through one ring of the chain, and make your aſſiſtant take the other end and ſtretch it out. Then cauſe him to move up and down, till you ſee him exactly in a line between the ſtick and the angle A; there let him ſet down a ſtick, as at *a*, and be ſure that the ſtick *a* be in a direct line between ⊙ and A; which you may eaſily perceive by ſtanding at ⊙, and looking to A. This done, cauſe him to move round towards B: and at the chain's end, let him there ſtick down another ſtick exactly in the line between ⊙ and B, as at *b*. Afterwards let him do the ſame at *c*, at *d*, and at *e*; and if there were more angles, let him plant a ſtick at the end of the chain in a right line between ⊙ and every angle. In the next place meaſure the higheſt diſtance between ſtick and ſtick, as

*a b*, 1 chain, 26 links; *b c*, 1 chain, 6 links; *c d*, 1 chain 0 links; *d e*, 1 chain, 20 links; and put




them down in your field-book accordingly. Measure alſo the diſtances between ⊙ and every angular point as ⊙ A, 18 chains, 10 links; ⊙ B, 15 chains, 0 links, *&c.* all which being put down, your field-book will appear thus:

Subtend-

| | | Ch. | Link. | | | Ch. | Link. |
|---|---|---|---|---|---|---|---|
| Subtending or chord-lines. | *a b* | 1 | 26 | Diagonal or center lines. | ⊙ A | 18 | 10 |
| | *b c* | 1 | 06 | | ⊙ B | 15 | 00 |
| | *c d* | 1 | 00 | | ⊙ C | 17 | 00 |
| | *d e* | 1 | 20 | | ⊙ D | 15 | 00 |
| | | | | | ⊙ E | 16 | 00 |

*To plot the field by theſe obſervations.*

Take from a large ſcale 1 chain, and ſetting one foot of the compaſſes in any convenient place of the paper, as at ⊙, make the circle *a b c d e*; then taking for your firſt ſubtendent, or chord-line, 1 chain, 26 links, ſet it upon the circle, as from *a* to *b*. From ⊙ through *a* and *b* draw lines, as ⊙ A ⊙ B, which produce as far as may be convenient. Then take your ſecond ſubtendent from the ſame large ſcale, *viz.* 1 chain, 6 links, and ſet it upon the circle from *b* to *c*, and through *c* draw the line ⊙ C. When you have thus ſet off all your ſubtendents, and drawn lines through their ſeveral marks, take a ſmaller ſcale; and upon the lines already drawn, ſet off the diagonal or center lines, as you find them in the field-book: thus upon the line ⊙ *a* A ſet off 18 chains, 10 links, from ⊙ to A; upon the line ⊙ *b* B, 15 chains, 0 links, from ⊙ to B; and ſo by all the reſt. Laſtly, Draw the lines AB, BC, CD, *&c.* and the work is finiſhed.

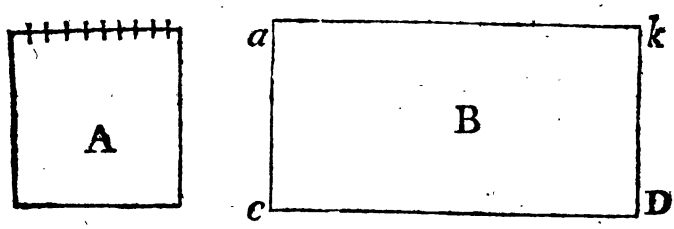
CHAP.

## CHAP. VII.

### *To find the Content of a Plot of Land.*

HAVING by this time ſufficiently ſhewed you how to ſurvey a field, and lay down a true figure thereof upon paper; I come in the next place to teach you how to caſt up the contents thereof; that is to ſay, to find out how many acres, roods, and perches it contains. And firſt,

*Of the ſquare and right angled parallelogram.*




To caſt up either of which, multiply one ſide by the other, and the product will be the content.

### EXAMPLE.

Let A be a true ſquare, each ſide being ten chains; multiply 10 chains 0 links, by 10 chains 0 links, *facit* 10|00000; from which I cut off the five laſt figures, and there remains juſt 10 acres for the ſquare A.

Again; In the parallelogram B, let the side *a k* or *c* D be 20 chains, 50 links; and the side *a c* or *k* D 10 chains, 0 links: multiply *a k* 20 chains, 50 links, by *a c* 10 chains 0 links, *facit*, 20|50000; from which cutting off the last five figures, remains 20 acres. Then if you multiply the figures cut off, *viz.* 50000 by 4, *facit*, 200000; from which cutting off five figures, remains 2 roods; and if any thing but 00 had been left, you must have multiplied again by 40; and then cutting off again five figures, you would have had the odd perches: see it done hereunder.

I need not have put down the multiplication by 40; but only to shew you in what order the figures will stand, when you have odd perches. The content of the long square B, is 20 acres, 20 roods, 00 perch.

| | |
|---|---|
| | 20 50 |
| | 10 00 |
| Acres—— | 20\|5000 00 |
| | 4 |
| Roods—— | 2\|000 00 |
| | 40 |
| Perches—— | 0 000 00 |

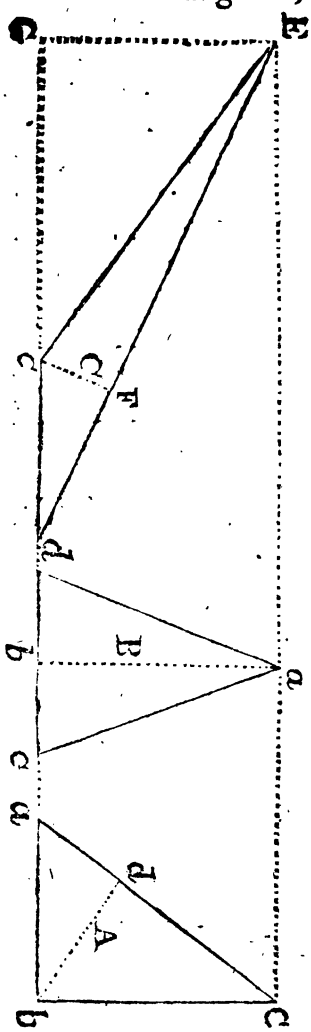
## *Of* TRIANGLES.

The content of all triangles are found by multiplying half the base by the whole perpendicular, or the whole base by half the perpendicular; or otherwise by multiplying the whole base and whole perpendicular together, and taking half that product for the content. Either of these three ways will do, take which you please.

EXAM-

## EXAMPLE.

In the triangle A, the baſe *a b* is 10 chains, 00 links; the perpendicular *c b*, 13 chains, 70 links: the half of which is 6 chains, 85 links; which multiplied by 10 chains, 00 links, *facit* 6|85000; from which cutting off five figures, there is left 6 acres. Then multiplying the remainder by 4, *facit* 340000; from which taking five figures, remains 3 roods. Again, the five figures cut off multiplied by 40, makes 1600000; from which taking five figures, leaves 16 perches. See the operation.




6, 85
10,00

Acres——6|85000
4

Roods——3|40000
40

Perches——16|00000

So

So likewiſe in the triangle B, the baſe *c d* is 10 chains, and the perpendicular *a b* 13 chains, 70 links; which multiplied by half the baſe, will give the ſame content. Alſo in the triangle C, if you multiply half the baſe E *d* by the perpendicular *c* F, the product will be the content of the triangle.

You may let fall your perpendicular from which angle you pleaſe, taking the line it falls upon for the baſe. Thus in the triangle A, if from *b* you let fall a perpendicular, take *b d*, and the half of *a c* for finding the content. Alſo in the triangle C, you may from E let fall your perpendicular, and although it falls without the triangle, yet the half of E G, multiplied by the whole of *c d*, ſhall be the true content of the triangle C. Note, *c d* muſt be produced before you can let fall the perpendicular.

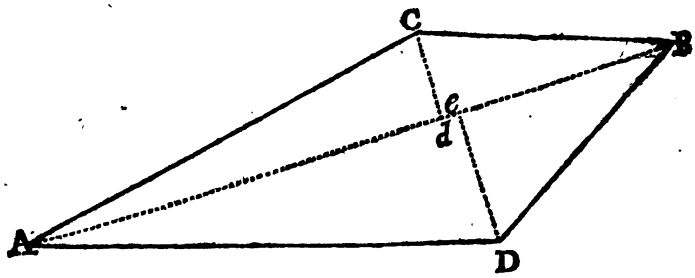
Remember this: all triangles have equal baſes, and lying between the ſame parallels, are of the ſame content: ſo the triangles A, B, C, having equal baſes, and lying between the parallel lines E C and G *b*, are therefore of the ſame content.

## *To find the content of a trapezium.*

Draw between two oppoſite angles a ſtrait line, as A B, then is the trapezium reduced into two triangles, *viz.* A B C and A B D, which you may meaſure as before taught; and adding their products together, you will have the true content of the trapezium. Or rather ſhorter, thus:

Take

Take the length of the line AB, which let be 37 chains, 0 links; take alſo the length of the



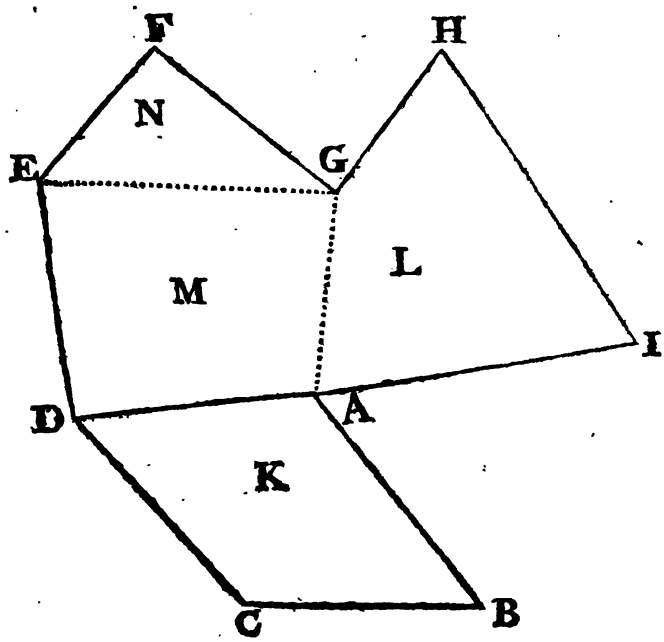

perpendicular D *e*, which let be 7 chains, 40 links; alſo C *d*, 4 chains, 80 links; add the two perpendiculars together, and they make 12 chains, 20 links; which multiply by half the common baſe AB, 18 chains, 50 links, and the product is 22 acres, 2 roods, 11 perches, as appears by the operation hereunder.

| | |
|---|---|
| Half the common baſe AB | 18,50 |
| The ſum of the two perpendiculars | 12,20 |
| | 37000 |
| | 3700 |
| | 1850 |
| Acres—— | 22\|57000 |
| | 4 |
| Roods—— | 2\|28000 |
| | 40 |
| Perches—— | 11\|20000 |

To

*To find the content of an irregular plot, conſiſting of many ſides and angles.*

To do this, you muſt firſt by drawing lines from angle to angle, reduce all the plot into trapezia and triangles; after which meaſure every trapezium and triangle ſeverally, and adding their contents all together, you will have the true content of the whole plot.




In

In the annexed figure ABCDEFGHI, draw the line AD, which cuts off the trapezium K; alſo the line AG, which cuts off the trapezium L. And laſtly the line GE, which makes the trapezium M, and the triangle N, ſo is the whole plot reduced into the three trapeziums K, L, M, and the triangle N: all theſe I meaſure as before taught, and put them down as hereunder:

| | Acres. | Roods. | Perches. |
|---|---|---|---|
| The trapezium K contains | 21 | 2 | 12 |
| The trapezium L contains | 26 | 3 | 18 |
| The trapezium M contains | 30 | 2 | 16 |
| The triangle contains | 6 | 2 | 24 |
| The content of the plot | 85 | 2 | 30 |

By which you find the whole plot to contain 85 acres, 2 roods, 30 perches.

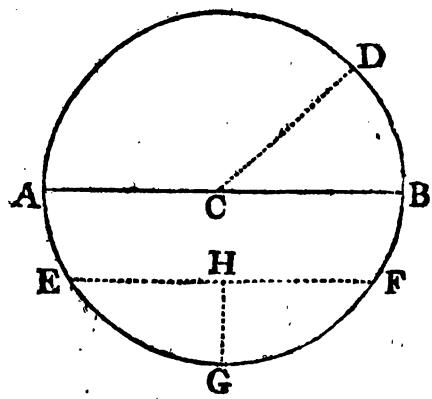
If the ſides of the plot had been given in perches, yards, feet, or any other meaſure, you muſt ſtill caſt up the content after this manner, and your product would have accordingly been perches, yards, &c. To turn which into acres, roods, and perches, I have largely treated of in the beginning of this book.

*To find the content of a circle, or any portion thereof.*

To find the content of the whole circle, it is convenient that firſt you know the diameter or circumference thereof; one of which being known, the

and the other is eaſily found; for as 7 is to 22, ſo is the diameter to the circumference; and as 22 is to 7, ſo is the circumference to the diameter.

In this annexed figure, the diameter AB is 2 chains or 200 links; which multiplied by 22




and the product divided by 7, gives 6 chains, 28 links, and ſomething more for the circumference. Now to know the ſuperficial content, multiply half the circumference by half the diameter, the product will be the content; half the circumference is 3 chains, 14 links; half the diameter, 1 chain, 0 links; which multiplied together, the product is 3,1400 ſquare links, or 1 rood, 10 perches, the content of the circle.

*By the diameter only to find the content.*

As 14 is to 11, ſo is the ſquare of the diameter to the content. The ſquare of the diameter is

40000, which multiplied by 11, makes 440000; which, divided by 14, gives 31428, or 1 rood, 14 perches, and ſomething more for the content.

*To meaſure the ſuperficial content of a ſector of a circle.*

Multiply half the compaſs thereof by the ſemidiameter of the circle, the product will anſwer your deſire.

In the foregoing circle, I would know the content of that little piece DCB; the arch DB is 78 links $\frac{1}{2}$; the half of it $39\frac{1}{4}$; which multiplied by 1 chain, 0 links, the ſemidiameter gives 3925 ſquare links, or $6\frac{1}{4}$ perches.

*To find the content of a ſegment of a circle, without knowing the diameter.*

Let EFG be the ſegment, the chord EF, is 1 chain 70 links, or 170 links; the perpendicular GH 50 links; now multiply $\frac{2}{3}$ of the one by the whole of the other, the product will be the content nearly; the two-thirds of 170 is the neareſt 113, which multiplied by 50, produces 5650 ſquare links, or 9 perches.

*To find the ſuperficial content of an oval.*

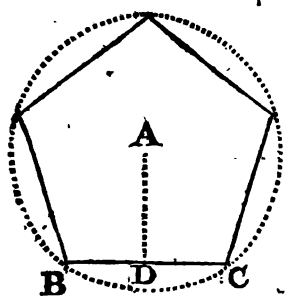
The common way is to multiply the long diameter by the ſhorter, and obſerve the product; and then, as if you were meaſuring a circle, ſay,

As 14 to 11, ſo the ſaid product to the content of the oval, but this is not exact. A better way is,

As 1, $\frac{27}{100}$ is to the length of the oval, ſo is the breadth to the content; or nearer, as 1,27324 to the length, ſo is the breadth to the content.

*To find the ſuperficial content of regular polygons; as pentagons, hexagons, ſeptagons, &c.*

Multiply half the ſum of the ſides by a perpendicular let fall from the center upon one of the ſides, the product will be the area or ſuperficial content of the polygon. In the following pentagon the ſide BC is 84 links, the whole ſum of the five ſides, therefore, muſt be 420, the half of which is 210; which, mutiplied by the perpendicular AD, 56 links gives 11760 ſquare links for the content, or 18 perches $\frac{8}{10}$ of a perch, almoſt 19 perches.




I have been ſhorter about theſe laſt three figures than my uſual method, becauſe they very rarely fall into the ſurveyor's way to meaſure them in land, though indeed in broad meaſure, paving, &c. often.

## CHAP. VIII.

*Of laying out new lands; very uſeful for ſurveyors, in his Majeſty's plantations in* America.

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*A certain quantity of acres being given, how to lay out the ſame in a ſquare figure.*

ANNEX to the number of acres given, 5 cyphers, which will turn the acres into links; then from the number thus increaſed, extract the ſquare root, which ſhall be the ſide of the propoſed ſquare.

### EXAMPLE.

Suppoſe the number given be 100 acres, which I am to lay out in a ſquare figure; I join to the 100 5 cyphers, and then it is 100,00000 ſquare links; the root of which is 3162 neareſt, or 31 chains, 62 links, the length of one ſide of the ſquare.

Again,

If I were to cut out of a corn-field one ſquare acre, I add to 1 five cyphers, and then is it 100000; the root of which is 3 chains, 16 links, and ſomething more for the ſide of that acre.

To

*To lay out any given quantity of acres in a right-angled parallelogram, whereof one ſide is given.*

Turn firſt the acres into links, by adding as before, five cyphers; that number thus increaſed divide by the given ſide, the quotient will be the other ſide.

EXAMPLE.

It is required to lay out 100 acres in a parallelogram, one ſide of which ſhall be 20 chains; firſt to the 100 acres I add five cyphers, and it is 100,00000; which divide by 20 chains, or 2000 links; the quotient is 50 chains, 0 links, for the other ſide or the parallelogram.

*To lay out any given number of acres in a parallelogram that ſhall be 4, 5, 6, or 7, &c. times longer than it is broad.*

In Carolina, and all lands lying by the ſides of rivers, except ſeigniories or baronies, are (or ought by order of the lords proprietors, to be) thus laid out. To do which, firſt, as above taught, turn the given quantity of acres into links, by annexing five cyphers: which ſum divide by the number given for the proportion between the length and breadth, as 4, 5, 6, 7, &c. the ſquare root of the quotient will ſhew the ſhorteſt ſide of ſuch a parallelogram.

## EXAMPLE.

Admit it were required of me to lay out 100 acres in a parallelogram, that ſhould be five times as long as broad: firſt to the 100 acres I add five cyphers, and it makes 100,00000; which ſum I divide by 5, the quotient is 2000000; the root of which is neareſt 14 chains, 14 links; and that, I ſay, ſhall be the ſhort ſide of ſuch a parallelogram; and by multiplying that 1414 by 5, ſhews me the longeſt ſide thereof to be 70 chains, 70 links.

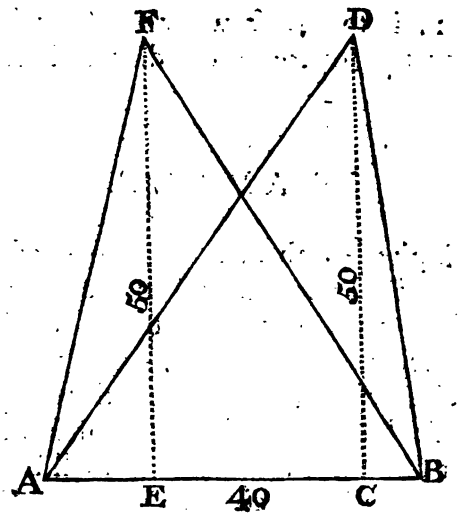
*To make a triangle upon a given baſe, that ſhall contain any number of acres.*

To double the given number of acres, annex five cyphers, and divide by the baſe, the quotient will be the length of the perpendicular required.

## EXAMPLE.

Upon a given baſe whoſe length is 40 chains, I am to make a triangle that ſhall contain 100 acres. Firſt, I double the 100 acres, and annexing five cyphers thereto, it makes 200,00000; which I divide by 40 chains, the given baſe; the quotient is 50 chains, 0 links, for the height of the perpendicular. As in this figure, AB is given baſe 40; on any part of it, as C, I make the perpendicular CD, equal

equal to 50 chains, and I draw the lines DA, DB, which make the triangle DAB, containing juſt 100 acres, as required. If I had made the perpendicu-




lar EF equal to 50, and draw the lines FA, FB, I ſhould have made the triangle FAB, containing 100 acres, the ſame as DAB.

If you conſider this well when you are laying out a new piece of land, of any given content, in *America*, or elſewhere, although you meet in your way with many lines and angles; yet you may, by making a triangle to the firſt ſtation you began at, cut off any quantity required.

*To find the length of the diameter of a circle, which ſhall contain any number of acres required.*

Say as 11 is to 14, ſo will the number of acres given be to the ſquare of the diameter of a circle required.

## EXAMPLE.

What is the length of the diameter of a circle, whoſe ſuperficial content ſhall be 100 acres? Add five cyphers to the 100, and it makes 100,00000 links; which multiply by 14, *facit* 140000000; which divided by 11, gives for quotient 12727272; the root of which is 35 chains, 67 links, and better, almoſt 68 links: and ſo much ſhall be the diameter of the required circle.

I might add many more examples of this nature; ſuch as to make ovals, regular polygons, &c. that ſhould contain any aſſigned quantity of land. But becauſe ſuch things are merely ſpeculative, and ſeldom or never come in practice, I here omit them,

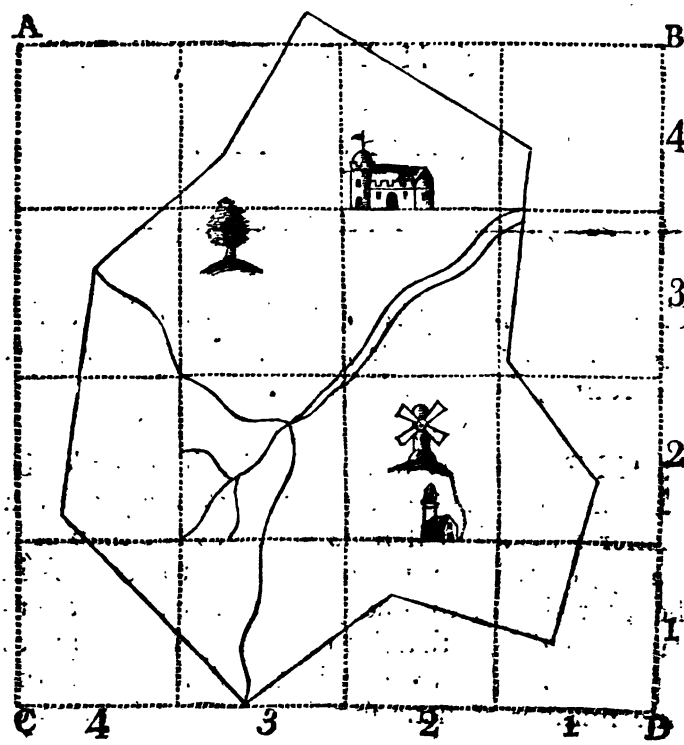
CHAP.

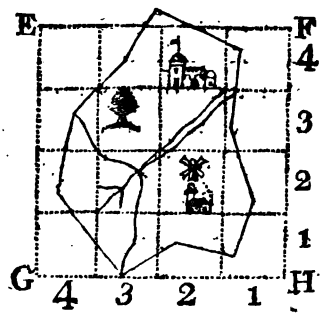
## CHAP. IX.

### *Of* REDUCTION.

*To reduce a large plot of land or map into a leſs compaſs, according to any given proportion; or,* è contra, *how to enlarge one.*

THE beſt way to do this, is, if your plot be not over large, to plot it over again by a ſmaller ſcale: but if it be large, as the map of a county, or the like, the only way is to compaſs in the plot firſt with one great ſquare; and afterwards to divide that into as many little ſquares as you ſhall ſee convenient. Alſo make the ſame number of little ſquares upon a fair piece of paper by a leſs ſcale, according to the proportion given. This done, obſerve in what ſquare, and part of the ſame ſquare, any thing remarkable happens to be, and accordingly put it down in your leſſer ſquares; and that you may not miſtake, it will be proper to number your ſquares. I cannot make this plainer than by giving you the following example, where the plot ABCD, made by a ſcale of 10 chains in an inch, is reduced into the plot EFGH, of 30 chains in an inch.




There

There are ſeveral other ways taught by ſurveyors for reducing plots or maps. Mr. *Rathborn*, and after him Mr. *Holwell*, adviſeth to make uſe of a ſcale or ruler, (having a center hole at one end, through which to pin it down on a table, ſo that it may play freely round) numbered from the center end to the other with lines of equal parts. The uſe of which is thus: lay down upon a ſmooth table the map or plot you would reduce, and glew it with mouth glew faſt to the table at the four corners thereof. Then take a fair piece of paper, of ſufficient bigneſs to contain your reduced plot, and lay that down upon the other; the middle of the laſt about the middle of the firſt. This done, lay the center of your reducing ſcale near the center of the white paper, and there with a needle through the center make it faſt; yet ſo, that it may play eaſily round the needle. Then moving your ſcale to any remarkable thing of the firſt plot, as an angle, a houſe, the bend of a river, or the like; ſee againſt how many equal parts of the ſcale it ſtands, as ſuppoſe 100; then taking the $\frac{1}{2}$, the $\frac{1}{4}$, the $\frac{1}{3}$, or any other part thereof, according to the proportion you would have the reduced plot to bear, and make a mark upon the white paper againſt 50, 25, 33, $\frac{1}{7}$, &c. of the ſame ſcale: and thus turning the ſcale about, you may firſt reduce all the outermoſt parts of the plot: which done, you muſt double or treble, &c. the lines in the leſſer plot, in order to reduce the innermoſt part near the center.

But I adviſe rather to have a long ſcale, made with a center hole for fixing it to the table, at the diſtance of about one-third part of the ſcale, ſo that $\frac{1}{3}$ of

of the ſcale may be one way numbered with equal parts from the center hole to the end; and $\frac{1}{3}$ part thereof numbered the other way to the end, with the ſame number of equal parts, though leſs. Upon this ſcale may be ſeveral lines of equal parts, the leſs to the greater, according to different proportions. Being thus provided with a ſcale, glew down upon a ſmooth table your greater plot to be reduced; and cloſe to it, upon the ſame table, a paper, about the bigneſs whereof you would have your ſmaller plot. Fix with a ſtrong needle the center of your ſcale, between both; then turning the longer end of your ſcale to any remarkable place in your plot; to be reduced, ſee what number of equal parts it cuts, as ſuppoſe 100; there holding faſt the ſcale, againſt 100 upon the ſmaller end of your ſcale make a mark upon the white paper. Proceed thus round all the plot, drawing lines, and putting down all other particulars as you proceed, for fear of confuſion through many marks in the end; and when you have done, although at firſt the reduced plot will ſeem to be quite contrary to the other, yet when you have unglewed it from the table, and turned it about, you will find it to be an exact epitome of the firſt. You may have for this work divers centers made in one ſcale, with equal parts proceeding from them accordingly; or you may have ſeveral ſcales, according to the different proportions, which is better.

What has been hitherto ſaid concerning the reducing of a plot from a greater volume to a leſs, the ſame is to be underſtood, *vice verſâ*, of enlarging a plot from a leſs to a greater. But this laſt ſeldom comes in practice.

To

*To change cuſtomary meaſure into ſtatute, and the contrary.*

In ſome parts of *England*, for wood-lands, and in moſt parts of *Ireland*, for all ſorts of land, they account 18 feet to a perch, and 160 ſuch perches to an acre, which is called *cuſtomary meaſure*: whereas our true meaſure for land, by *act of parliament*, is but 160 perches for one acre, at 16 feet and an half to the perch. Therefore to reduce the one from the other, the rule is,

As the ſquare of one ſort of meaſure
is to the ſquare of the other:
So is the content of the one
to the content of the other.

Thus, if a field meaſured by a perch of 18 feet, accounting 160 perches to the acre, contain 100 acres; how many acres ſhall the ſame field contain by a perch of 16 feet $\frac{1}{2}$?

Say, If the ſquare of 16 feet $\frac{1}{2}$, *viz.* 272.25, give the ſquare of 18 feet, *viz.* 324, What ſhall 100 acres *cuſtomary* give? Anſwer, 119 $\frac{9}{16}$ of an acre *ſtatute* meaſure.

*Knowing the content of a piece of land, to find what ſcale it was plotted from.*

Firſt, By any ſcale meaſure the content of the plot, which done, ſay:

As the content thus found, is to the ſquare of the ſcale I tried by;
So is the true content, to the ſquare of the true ſcale it was plotted by.

Admit

Admit there is a plot of a piece of land containing 10 acres, and meaſuring it by a ſcale of 11 equal parts to an inch, I find it contains 12 acres $\frac{1}{10}$ of an acre: then I ſay, if 12 $\frac{1}{10}$ give 121 (the ſquare of the number of equal parts in the length of the ſcale I uſed) what ſhall 10 give? Anſwer, 100, whoſe ſquare root 10 is the number of equal parts in the length of the ſcale the plot was protracted by. Therefore if the ſcale I meaſured by contained 11 equal parts to an inch, the plot was laid down from a ſcale of 10 equal parts to an inch.

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## CHAP. X.

### *Inſtructions for ſurveying a manor, county, or whole country.*

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*To ſurvey a manor, obſerve the following rules.*

1. WALK or ride over the manor once or twice, that you may have, as it were, a map of it in your head; by which means you may the better know where to begin, and proceed on with your work.

2. If you can conveniently ſurvey round the whole manor with your chain and inſtrument, taking all the angles, and meaſuring all the lines thereof; taking notice of roads, lanes, or commons, as you

croſs them: alſo minding well the ends of all dividing hedges, where they butt upon your bound-hedges, in this manner.

3. Take a true draught of all the roads and bye-lanes in the manor, putting down alſo the true buttings of all the field-fences to the road. If the road be broad, or goes thro' ſome common or waſte ground, the beſt way is to meaſure, and take the angles on both ſides thereof; but if it be a narrow lane, you may only meaſure along the midſt thereof, taking the angles and off-ſets to the hedges, and meaſure your diſtances truly: alſo if there be any conſiderable river either bounds or runs through the manor, ſurvey that alſo truly, as is hereafter taught.

4. Make a true plot upon paper of all the foregoing work, and then will you have a reſemblance of the manor, though not compleat; which to make ſo, go to all the buttings of the hedges, and there ſurvey every field diſtinctly, plotting it accordingly every night, or rather twice a day, till you have perfected the whole manor.

5. When thus you have plotted all the fields, according to the buttings of the hedges found in your firſt ſurveys, you will find that you have very nigh, if not quite, done the whole work: but if there be any fields which lie ſo within others, that they are not bounded on either ſide by a road, lane, or river, then you muſt alſo ſurvey them, and place them in your plot, accordingly as they are bounded by other fields.

6. Draw

6. Draw a fair draught of the whole, putting down therein the manor-houſe, and every other conſiderable houſe, wind-mill, water-mill, bridge, wood, coppice, croſs paths, rills, runs of water, ponds, and any other matters notable therein. Alſo in the fair draught, let the arms of the lord of the manor be neatly drawn, and a compaſs in ſome waſte part of the paper; alſo a ſcale, the ſame by which it was plotted. You muſt alſo beautify your map with colours and cuts, according as you ſhall ſee convenient.

Write down alſo in every field the true content thereof; and if it be required, the names of the preſent poſſeſſors, and their tenures, by which they hold it of the lord of the manor.

The quality alſo of the land you may take notice of, as you paſs over it, if you have judgment therein, and it be required of you.

*To take the draught of a county or country.*

1. If the county or country is in any place thereof bounded with the ſea, ſurvey firſt the ſea-coaſt thereof, meaſuring it all along with the chain, and taking all the angles thereof truly.

2. Which done, and plotted by a large ſcale, ſurvey next all rocks, ſands, or other obſtacles that lie at the entrance of every river, harbour, bay, or road upon the coaſt of that county or country; which plot down accordingly, as ſhall be ſhewn farther on.

3. Sur-

3. Survey all the roads, taking notice as you go along, of all towns, villages, great houſes, rivers, bridges, mills, croſs-ways, &c. Alſo take the bearing at two ſtations of ſuch remarks as you ſee out of the road, or by the ſide thereof.

4. Alſo ſurvey all the rivers, taking notice how far they are navigable, what branches run into them, and where they begin; what fords they have, bridges, &c.

5. All this being exactly plotted, will give you a truer map of the country, than any that I know of hath yet been made in *England*. However, you may look upon old maps, and if you find therein any thing worth notice, that you have not yet put down, you may go and ſurvey it; and thus by degrees you may finiſh a county, ſo as not to leave out even one gentleman's houſe; for it will ſcarcely happen but ſome very remarkable thing will come into your view, either from the roads, the rivers, or ſea coaſt.

6. Laſtly, With a large quadrant take the true latitude of the place, in three or four places of the county; which put down upon the edge of your map accordingly.

## CHAP. XI.

### *Of dividing lands.*

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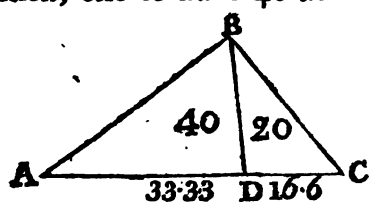
#### *To divide a triangle ſeveral ways.*

SUppoſe ABC a triangular piece of land, containing 60 acres, to be divided between two men, one to have 40 acres cut off towards A, and the other 20 acres towards C; and the line of diviſion to proceed from the angle B. Firſt, meaſure the baſe AC, *viz.* 50 chains; then ſay by the Rule of Three, if the whole content 60 acres give 50 chains for its baſe, what ſhall 40 acres give? Multiply and divide, the quotient will be 33 chains, 33 links; which ſet off upon the baſe from A to D, and draw the line BD, which ſhall divide the triangle as was required. If it had been required to have divided the ſame into 3, 4, 5, or more unequal parts in given proportions, you muſt, as before, by the Rule of Three, have found the length of each ſeveral baſe; much after the ſame manner as merchants calculate their loſs or gain by the rule of Fellowſhip.

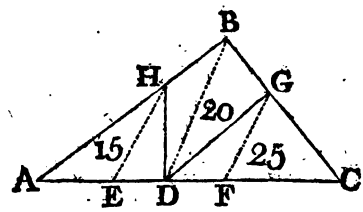



There are ſeveral ways of doing this geometrically, without the help of arithmetic; but my buſineſs

buſineſs is not ſo much to ſhew you what may be done, as how to do it by the moſt eaſy and practicable way.

*To divide a triangular piece of land into any number of unequal parts, by lines proceeding from any point aſſigned in any ſide thereof.*

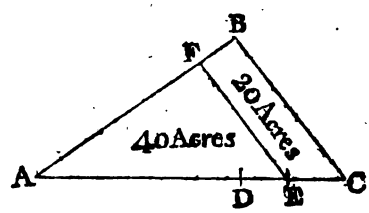
Let A B C, the triangular piece of land, containing 60 acres, be divided between three men, the firſt to have 15 acres, the ſecond 20, and the third 25 acres, and the lines of diviſion to proceed from D: firſt, meaſure the baſe, which is 50 chains; then divide the baſe into three parts, as you have been before taught, by ſaying, if 60 give 50, what ſhall 15 give? Anſwer, 12 chains, 50 links for the




firſt man's baſe; which ſet off from A to E. Again, ſay, If 60 give 50, what ſhall 20 give? Anſwer, 16 chains, 66 links for the ſecond man's baſe; which ſet off from E to F; then conſequently the third man's baſe, *viz.* from F to C, muſt be 20 chains, 84 links. This done, draw an obſcure line from the point aſſigned D, to the oppoſite angle B; and from E and F draw the lines E H F G parallel to B D. Laſtly, From D draw the lines D H, D G, which ſhall divide the triangle into three ſuch parts as were required.

*To divide a triangular piece of land, according to any proportion given by a line parallel to one of the ſides.*

ABC is the triangular piece of land, containing 60 acres, the baſe AC is 50 chains. This piece of




land is to be divided between two men, by a line parallel to BC, in ſuch proportion that the one have 40 acres, the other 20.

Firſt, Divide the baſe, as has been before taught, and let the point of diviſion fall in D, AD being 33 chains, 33 links; and DC 16 chains, 67 links.

Secondly, Find a mean proportion between AD and AC; by multiplying the whole baſe 50 by AD 33, 33, the product is 1666.5000; of which the ſquare root being extracted, gives 40 chains, 82 links; ſet this off from A to E. Laſtly, From E draw EF parallel to BC, which divides the triangle as demanded.

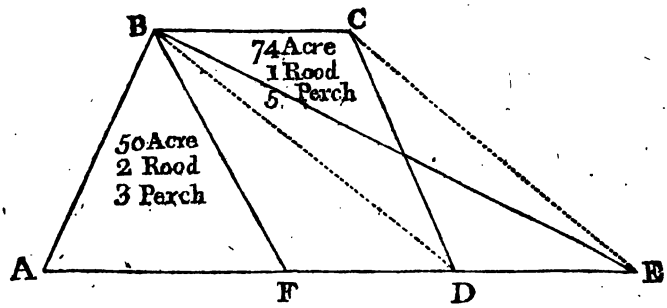
*Of dividing four-ſided figures or trapezia.*

Before I begin to teach you how to divide pieces of land of four ſides, it is convenient firſt to ſhew you how to change any four-ſided figure into a tri-

angle; which done, the work will be the ſame as in dividing triangles.

*To reduce a trapezium into a triangle, by lines drawn from any angle thereof.*

Let ABCD be the trapezium to be reduced into a triangle, and B the angle aſſigned: draw the




obſcure line BD, and from C make a line parallel thereto, as CE; extend alſo the baſe AD, till it meet CE in E: then draw the line BE, which ſhall make the triangle BAE equal to the trapezium ABCD.

Now to divide this trapezium according to any aſſigned proportion, is no more than to divide the triangle ABE, as before taught; which will alſo divide the trapezium.

## EXAMPLE.

Suppoſe the trapezium ABCD, containing 124 acres, 3 roods, and 8 perches, is to be divided be-

tween two men, the firſt to have 50 acres, 2 roods, and 3 perches; the other 74 acres, 1 rood and 5 perches, and the line of diviſion to proceed from B.

Firſt, Reduce all the acres and roods into perches, then will the content of the trapezium be 19968 perches; the firſt man's ſhare 8083 perches, the ſecond 11885.

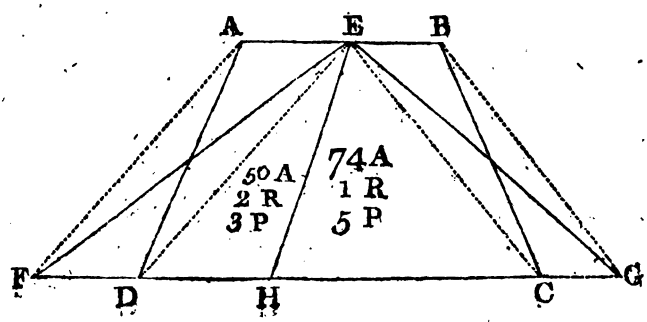
Secondly, Meaſure the baſe of the triangle, *viz.* AE 78 chains, 00 links:

Then ſay, If 19968 the whole content give for its baſe } 78 chains, 00 links,
What ſhall 8083, the firſt man's part, give? Anſwer } 31 chains, 52 links;

which ſet off from A to F, and drawing the line FB you divide the trapezium as deſired; the triangle ABF being the firſt man's portion, and the trapezium BCFD the ſecond's.

*How to reduce a trapezium into a triangle, by lines drawn from a point aſſigned in any ſide thereof.*

ABCDA the trapezium, E the point aſſigned, from whence to reduce it into a triangle, and run the diviſion line. The trapezium is of the ſame

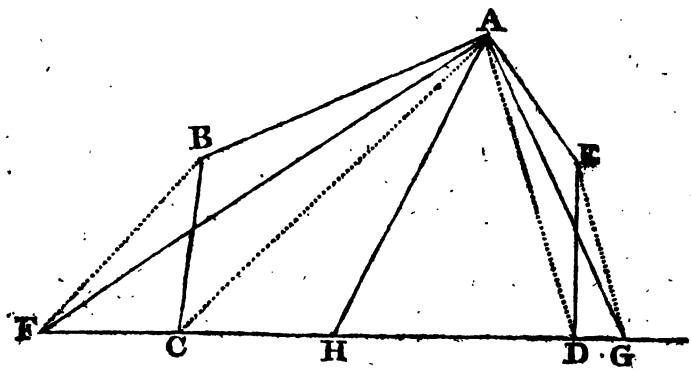



content

content as the former, *viz.* 19968 perches; and it is to be divided as before, *viz.* one man to have 8083 perches, and the other 11885. Firſt, for to reduce it into a triangle, draw the lines ED, EC, and from A and B make lines parallel to them, as AF, BG; then draw the lines EG, EF, and the triangle EFG will be equal to the trapezium ABCDA, which is to be divided as before; therefore find, by the rule of proportion, what the firſt man's baſe muſt be, *viz.* 31 chains, 52 links, ſet it from F to H, and draw the line HE; ſo ſhall you divide the trapezium according to the former proportion.

*To reduce an irregular five-ſided figure into a triangle, and to divide the ſame into any given proportion.*

Let ABCDEA be the five-ſided figure; to reduce this into a triangle, firſt draw the lines AC,

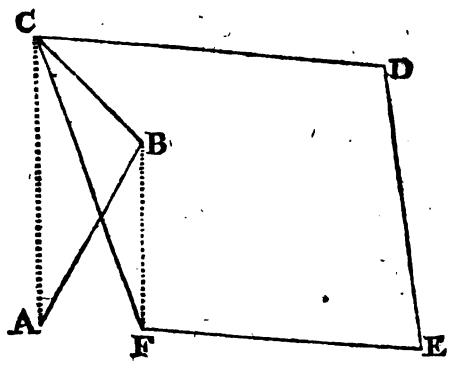



AD; and parallel thereto BF, EG, extending the baſe from C to F, and from D to G; then draw the lines AF, AG, which will make the triangle AFG equal to the five-ſided figure. If

this were to be divided into two equal parts, you muſt take FH equal to half of the baſe of the triangle; and from H draw the line HA, which divides the figure ABCDE into two equal parts.

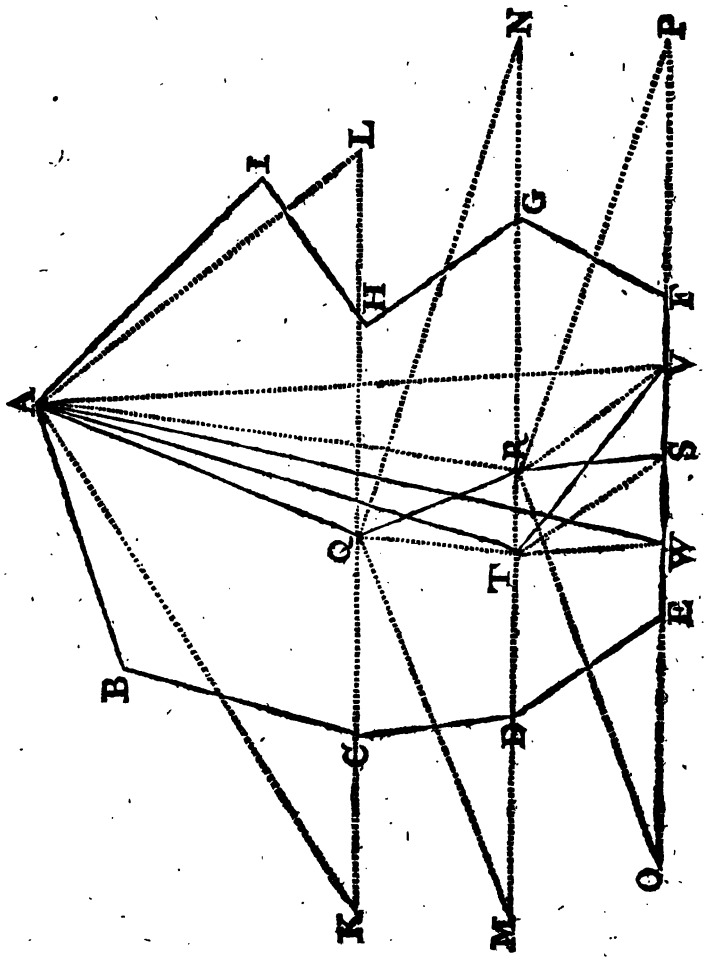
*If in dividing the plot of a field, there be outward angles, you may change them after the following manner.*

Suppoſe ABCDEA be the plot of a field, and B the outward angle.




Draw the line CA; parallel thereunto draw alſo BF; join the points C, F, and the five-ſided figure, having one angle, is now reduced into a four-ſided figure, or trapezium; which you may again reduce into a triangle, as has been before taught.

*To divide an irregular plat of any number of ſides, according to any given proportion, by a ſtrait line drawn through it.*



ABCDEFGHIA is a field to be divided equally between two men, by a ſtraight line proceeding from A.

Firſt, Conſider how to divide the field into five-ſided figures and trapezia, that you may the better reduce it into triangles: as by drawing the line KL, you cut off the five-ſided figure ABCHI; which reduce into the triangle AKL, and meaſuring half the baſe thereof, which will fall at Q, draw the line QA.

Secondly, Draw the line MN, and from the point Q reduce the trapezium CDGH into the triangle MNQ; which again divide into halfs, and draw the line QR.

Thirdly, From the point R reduce the trapezium DEFG, into the triangle ROP; and taking half the baſe thereof, draw the line RS; and then have you divided this irregular figure into two equal parts by the three lines AQ, QR, RS.

Fourthly, Draw the line AR, alſo QT parallel thereto. Draw alſo AT, and then have you turned two of the lines into one.

Fifthly, From T draw the lines TS, and parallel thereto the line RV; draw alſo TV. Then is your figure divided into two equal parts by the two lines AT and TV.

Laſtly, Draw the line AV, and parallel thereto TW. Draw alſo AW, which will cut the figure into two equal parts by a ſtrait line, as was required.

You may, if you pleaſe, divide the whole of ſuch a figure into triangles; and then divide each triangle from the point where the diviſion of the laſt fell, and then will your figure be divided by a crooked line, which you may bring into a ſtrait one, as above.

The

The above is a good way of dividing lands; but ſurveyors ſeldom take ſo much pains about it; I ſhall therefore ſhew you how they commonly abbreviate their work, as is indeed

*An eaſy way of dividing lands.*

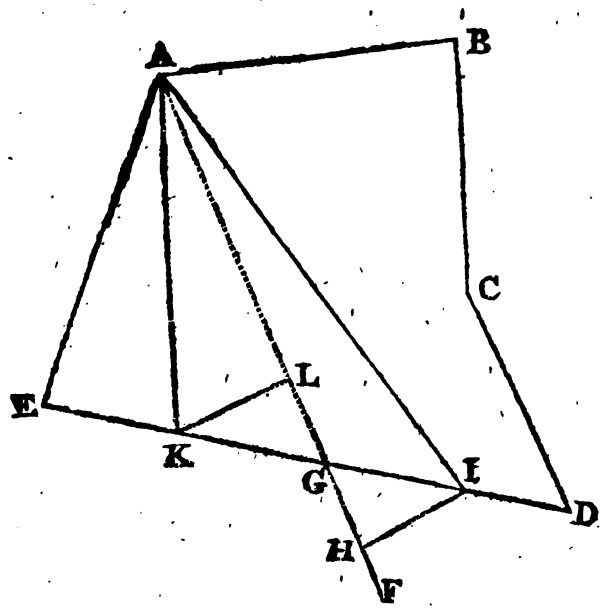
Admit the following figure ABCDE contains 46 acres, to be divided equally between two men, by a line proceeding from A.

Draw firſt a line at pleaſure through the figure, as the line AF. Then caſt up the content of either part, and ſee what it wants, or what it is more than the true half ſhould be.

As for example; I caſt up the content of AEG, and find it to be but 15 acres; whereas the true half is 23 acres; 8 acres being in the part ABCDG more than AEG. Therefore I make a triangle containing 8 acres, and add to it AEG, as the triangle AGI; then the line AI parts the figure into two equal quantities.

But more plainly how to make this triangle: meaſure firſt the line AG, which is 23 chains 60 links. Double the 8 acres, they make 16; to which add five cyphers to turn them into chains and links, and then they make 160000; which divide by AG 2360, the quotient is 6 chains 77 links; for the perpendicular HI, take from your ſcale 6 chains, 77 links, and ſet it ſo from the baſe AGF, that the end of the perpendicular may juſt touch the line ED, which ſuppoſe at I. Then draw the line AI, which makes the triangle ACI juſt 8 acres, and divides the whole figure as deſired.

If




If it had been required to have ſet off the perpendicular the other way, you muſt ſtill have made the end of it but juſt touch the line ED, as LK does: for the triangle AKG is equal to the triangle AGI, each 8 acres.

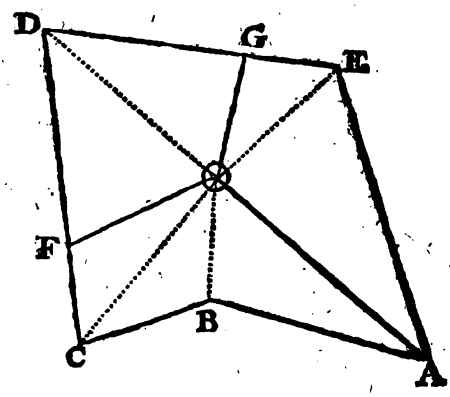
And thus you may divide any piece of land of any number of ſides, according to any proportion, by ſtrait lines through it with equal certainty, and more eaſe than the former way.

Note, You might alſo have drawn the line AD, and meaſured the triangle AGD, and afterwards have divided the baſe GD in I, according

ing to the given proportion; this will appear plainer by the following example:

Suppoſe a field containing 27 acres, is to be divided between three men, each to have 9 acres, and the lines of diviſion to run from a pond in the field, ſo that each perſon may have the benefit of the water, without going over another's land.

Firſt, from the pond ⊙ draw lines to every angle, as ⊙ A, ⊙ B, ⊙ C, ⊙ D, ⊙ E; and then




is the figure divided into five triangles; meaſure each of theſe, and put their contents down ſeverally, which reduce into perches, and you will have the

| | | | |
|---|---|---|---|
| Triangle | A ⊙ B | be | 674 |
| | B ⊙ C | | 390 |
| | C ⊙ D | | 1238 |
| | D ⊙ E | | 911 |
| | E ⊙ A | | 1107 |

Perches.

The whole content is 4320 perches, or 27 acres, and each man's proportional part 1440 perches.

From

From ⊙ to any angle draw a line for the firſt diviſion-line, as ⊙ A, then conſider that the firſt triangle A ⊙ B is but 674 perches, and the ſecond B ⊙ C 390, both together but 1064 perches, leſs by 376 than 1440, one man's portion. You muſt therefore cut off from the third triangle C ⊙ D 376 perches for the firſt man's dividing line; which you may do thus: the baſe D C is 18 chains, the content of the triangle 1238 perches: ſay then, if 1238 perches give the baſe 18 chains 00 links, what ſhall 376 perches give? Anſwer 5 chains, 45 links; which ſet from C to F, and drawing the line ⊙ F you have the firſt man's part, *viz.* A ⊙ F C B A.

Secondly, Obſerve the remaining part of the triangle C ⊙ D, after 376 is taken out, and you will find it to be 861 perches, which is leſs than 1440 by 578. Therefore from the triangle D ⊙ E cut off 578 perches, and the point of diviſion will fall in G. Draw the line ⊙ G, which with ⊙ A and ⊙ F, divides the figure into three equal parts.

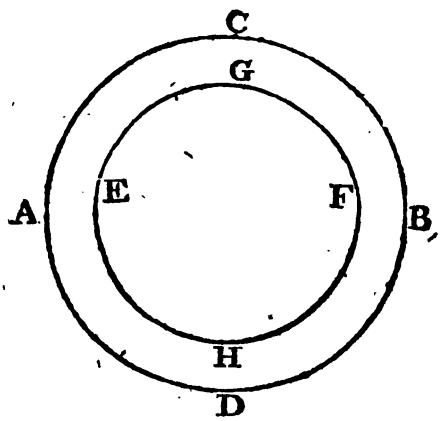
*To divide a circle according to any proportion, by a line concentric with the firſt.*

The areas of circles are in proportion to one another as the ſquares of their ſemi-diameters; therefore, if you divide the ſquare of the ſemi-diameter by the proportion given, and extract the ſquare root, you will have your deſire.

EXAMPLE.

A B C D be a circle to be equally divided between two men.

The




The diameter thereof is 2 chains.
The ſemidiameter 1 chain, or 100 links.
The ſquare thereof 10000.
Half the ſquare 5000.
The root of the half 71 links; which take from your ſcale, and upon the ſame center deſcribe the circle GEHF, which will divide the circle ABCD into two equal parts.

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## CHAP. XII.

### Trigonometry: *or, The menſuration of right-lined triangles.*

THE uſe of the table of logarithm numbers I have ſhewed in *chap.* I. concerning the extraction of the ſquare root. Here follows

*The*

### *The uſe of the table of ſines and tangents.*

Any angle being given in degrees and minutes, how to find the ſine or tangent thereof.

Let 27 degrees 10 minutes be given, to find the ſine and tangent thereof. Firſt, in the table of ſines and tangents, at the head thereof ſeek for 27; and having found it, look down the firſt column on the left-hand under M, for the 10 minutes, and right againſt it under the title *Sin.* ſtands the ſine required, *viz.* 9,659517; alſo in the ſame line under the title *Tang.* ſtands the tangent of 27°. 10′, *viz.* 9,710282: but if the degrees exceed 45, then look at the foot of the tables for the degrees, and upon the right-hand column for the minutes; and right againſt it you will find the ſine and tangent above the title *Sine. Tang.* Thus the ſine of 64 degrees 50 minutes, is 9,956684; the tangent thereof is 10,328037.

### *To find the co-ſine, or ſine complement; the co-tangent, or tangent complement of any given number of degrees and minutes.*

The co-ſine, or co-tangent, of an angle, is the ſine and tangent of the remaining degrees and minutes, after ſubtracting it from 90; thus, take 25 degrees 10 minutes from 90 degrees, 00 min. there remains 64 degrees, 50 minutes; the ſine of which is, as before, 9,956684: and that it is alſo the ſine complement of 25 degrees, 10 minutes.

But

But a more ready way to find the co-ſine, or co-tangent of any number of degrees given, is to look for the degrees and minutes as before taught, for ſines and tangents; and right againſt it under titles co-ſine and co-tangent; or above, if the degrees exceed 45, you will find the co-ſine or co-tangent required: thus the co-ſine of 30 degrees, 15 minutes, is 9,936431; the co-tangent of 58 degrees, 10 minutes, is 9,792974.

*A ſine or tangent, co-ſine or co-tangent being given, to find the degrees and minutes belonging thereto.*

This is the converſe of the former; for you muſt ſeek in the tables for the ſine, *&c.* given, or the nigheſt that can be found thereto, and right againſt it you will find the *minutes* and *degrees* over-head. Let the ſine 8,742259 be given, right againſt it ſtands 3 *degrees*, 10 *minutes*.

Remember that multiplication is performed with theſe logarithmic tables by addition, and diviſion by ſubtraction. If I were to multiply 5 by 4, firſt I look for the logarithm of 5, which is 0,698970
The logarithm of 4 is 0,602060

Added together, they make 1,301030

which 1,301030 I ſeek for in the table of logarithms; and right againſt, under title *num.* ſtands 20, the product of 5 multipled by 4.

If I were to divide 20 by 5, firſt I look for the logarithm of 20, which, as above, is . 1,301030
the logarithm of 5 is 0,698970

After ſubtraction remains 0,602060

and the number anſwering to this logarithm you will find to be 4.

And thus by addition and ſubtraction the rule of three is performed with the logarithms, *viz.* by adding the ſecond and third terms together, and from their ſum ſubtracting the firſt.

## EXAMPLE.

If 15 give 32, what will 45 give?
The logarithm of 15 is 1,176091

The logarithm of 45 is 1,653212
The logarithm of 32 is 1,505150

The two laſt added together make 3,158362

From that ſum I ſubtract the firſt term, and there remains — 1,982271

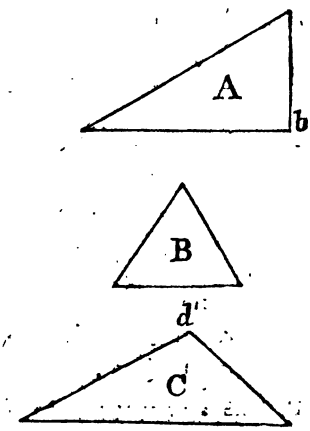
Againſt 1,982271 in the table I find the number 96. I anſwer therefore, If 15 gives 32, 45 will give 96.

This you muſt obſerve to do in the following caſes of triangles, always to add the ſecond and third numbers together, and from their product to ſubtract the firſt, the remainder will be the logarithm number, ſine, or tangent of your required ſide or angle.

*Certain theorems for the better underſtanding right-lined triangles.*

1. A right-lined triangle is a figure comprehended within three ſtrait lines.

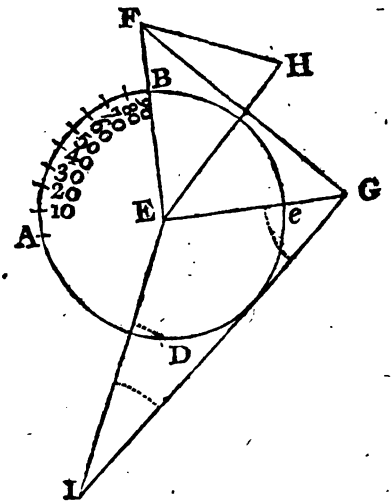
2. It is either right-angled as A, having one right angle, which contains juſt 90 degrees, *viz.* that at *b*; or elſe oblique as B, which conſiſts of three acute angles, neither of them ſo great as 90 degrees; or as C, which conſiſts of two acute angles and one obtuſe, *viz.* that at *d*.




3. All the three angles of any triangle are equal to two right angles, or 180 degrees; ſo that one angle being known, the ſum of the other two becomes known alſo; or two being known, the third may be found by ſubtracting the two known angles out of 180 degrees; the remainder is the third angle.

To underſtand well what the quantity of an angle is, take this following illuſtration.

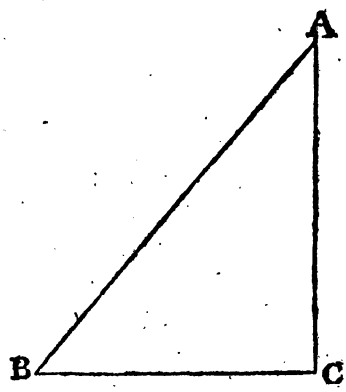
Let ABCD be a circle, whoſe circumference is divided (as all circles are ſuppoſed to be) into 360 equal parts called degrees, and each of theſe again divided into 60 equal parts, which are called minutes: now a right-angled triangle is that




which cuts off one-fourth part of this circle, *viz.* 90 degrees, ſuch is the triangle F E G.

An angle cut off being leſs than 90 degrees, is acute as the angles H E F.

The angle G E I is obtuſe becauſe the two lines that proceed from E, take in betwixt them more than a quarter of the circle.




5. Every

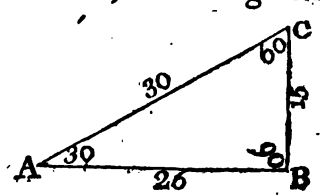
5. Every triangle hath ſix parts, *viz.* three ſides and three angles; the ſides are ſometimes called legs; but moſt commonly in right-angled triangles the bottom line, as BC, is called the baſe, then is AC the perpendicular; but the longeſt line AB is always called the hypothenuſe. The ſides are proportional to the ſines of their oppoſite angles; ſo that any three parts of the ſix being known, (except the three angles) the reſt may eaſily be found.

6. When an angle exceeds 90 degrees, ſubtract it out of 180, and work by the remainder, which is called the ſupplement thereof.

## CASE I.

*In a right-angled triangle, the baſe being given, and the acute angle at the baſe; to find the hypothenuſe and perpendicular.*

In a right-angled triangle ABC, there is given the baſe AB, 26 equal parts, as yards, perches, &c. and the angle at A 30 degrees; to find the length of the hypothenuſe AC;




As the ſine complement of the angle at A
is to the logarithm of the baſe 26,
So is the radius or ſine of 90°
to the logarithm of the hypothenuſe AC equal 30.

| | |
|---|---|
| The ſine complement of 30 degrees is | 9,937531 |
| The logarithm of 26 is | 1,414973 |
| The radius, or ſine of 90° | 10,000000 |
| The two laſt added together | 11,414973 |
| Remains, after ſubtracting the firſt numb. | 1,477442 |

Which if you look for in your table of logarithms, you will find the neareſt number anſwering thereto to be 30, the length of the hypothenuſe required.

Note in your table, when you cannot find exactly the logarithm you look for, you muſt take the neareſt thereto; as in this example, I find 1,477121 to be the neareſt to 1,477442. Note alſo, that the ſine complement of the angle at A, is the right ſine of that at C. For the angle at A in a right-angled triangle being given, you may, by ſubtraction, eaſily find the angle at C; becauſe by the rule above, all the three angles of a triangle are equal to two right angles, or 180 degrees; conſequently, if you take the ſum of the right angle at B 90°, and that at A 30° out of 180°, there will remain the angle at C equal to 60°. But to purſue our queſtion,

*To find the perpendicular.*

As the ſine of the angle ACB 60°
is to the log. of the baſe AB 26;
So is the ſine of the angle CAB 30°
to the log. of the perpendicular CB 15.

*Note,*

*Note*, When three letters are put to expreſs an angle, the middle letter denotes the angular point.

| | |
|---|---|
| The ſine of 63 degr. is | 9,937531 |
| The log. of the baſe AB 26 is | 1,414973 |
| The ſine of 30 degr. is | 9,698970 |
| The ſum or the two laſt | 11,113943 |

From which ſubtract the firſt, remains 1,176412
The neareſt number anſwering to which is 15, equal to the length of the perpendicular line CB.

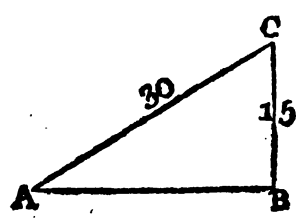
*Otherwiſe, the hypothenuſe* AC *equal to* 30, *being firſt found, you may find the perpendicular thus:*

| | |
|---|---|
| As the ſine of the right-an. CBA or rad. | 10,000000 |
| is to the log. of the hypoth. AC 30 | 1,477121 |
| So is the ſine of the angle CAB 30 deg. | 9,698970 |
| to the log. of the perpendicular 15, | 11,176091 |

## CASE II.

*The perpendicular and acute angle* ACB *being given, to find the baſe and hypothenuſe.*

Let the perpendicular CB be 15, as before, the angle ACB 60 deg. to find the baſe.



As the co-ſine of the angle ACB
  is to the logarithm of the perpendicular BC 15;
So is the ſine of the angle ABC
  to the logarithm of the baſe AB 26.

| | |
|---|---|
| The co-ſine of the angle ACB 60°, is | 9,698970 |
| The logarithm of CB 15 is | 1,176091 |
| The ſine of the angle ACB 60 is | 9,937531 |
| | 11,113622 |
| The neareſt log. anſwering to 26, is | 1,414652 |

*For the hypothenuſe.*

As the ſine complement of the angle ACB 60°,
  is to the log. of the perpendicular CB 15,
So is the ſine of the angle ABC, or 90°,
  to the log. of the hypothenuſe 30°.

| | |
|---|---|
| The co-ſine of the angle ACB is | 9,698970 |
| The log. of the perpend. CB 15 is | 1,176091 |
| The radius | 10,000000 |
| The log. of the hypothenuſe 30 | 1,477121 |

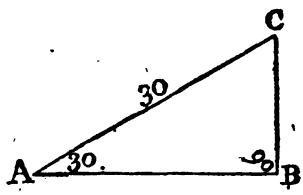
*Or, the baſe being firſt found, find the hypothenuſe thus.*

| | |
|---|---|
| As the ſine of the angle ACB 60° | 9,937531 |
| is to the log. of the baſe 26 | 1,414973 |
| So is the radius | 10,000000 |
| to the log. of the hypothenuſe (30) | 1,487442 |

CASE

## CASE III.

*The hypothenuſe, and one of the acute angles given, to find the baſe and perpendicular.*




Let the hypothenuſe be AC 30;
The angle CAB 30°.

*To find the baſe* AB, *work thus:*

| | |
|---|---|
| As radius or the ſine of the right angle CBA 90° | 10,000000 |
| is to the log. of the hypoth. AC 30 | 1,477121 |
| So is the coſine of the angle CAB 30° | 9,937531 |
| to the log. of the baſe AB (26) | 11,414652 |

*To find the perpendicular* BC, *work thus:*

| | |
|---|---|
| As radius or the ſine of the right angle CBA 90° | 10,000000 |
| is to the log. of the hypoth. AC 30 | 1,477121 |
| So is the ſine of the angle CAB 30 | 9,698970 |
| to the log. of the perpend. (15) | 11,176091 |

*Or,*

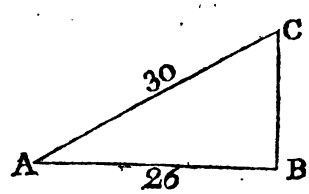
*Or the baſe being firſt found, find the perpendicular thus:*

| | |
|---|---|
| As the co-ſine of the angle CAB 30° | 9,937531 |
| is to the log. of the baſe AB 26 | 1,414973 |
| So is the ſine of the angle CAB (30°) | 9,698970 |
| | 11,113943 |
| to the neareſt log. of the perpend. (15) | 1,176412 |

## CASE IV.

*The hypothenuſe and baſe being given, to find the acute angles* ACB *and* CAB.

Let AC, the hypothenuſe, be 30 equal parts, AB the baſe 26; required the angle ACB,




As the logarithm of the hypothenuſe AC 30,
is to the radius, or the ſine of the angle CBA 90°;
So is the logarithm of the baſe AB 26,
to the ſine of the angle ACB 60°.

*The*

*The Operation.*

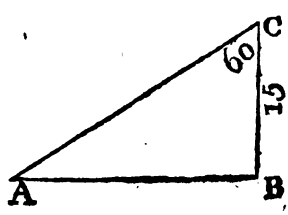
| | |
|---|---|
| The log. of the hypothenuſe AC 30 is | 1477121 |
| The radius | 10,000000 |
| The logarithm of the baſe AB 26 | 1,414973 |
| The ſine of ACB the angle required 60° | 9,937852 |

*For the angle* CAB, *work thus:*

| | |
|---|---|
| As the log. of the hypothenuſe AC 30 | 1,477121 |
| is to the radius or ſine of 90° | 10,000000 |
| So is the logarithm of the baſe AB 26 | 1,414973 |
| to the co-ſine of the angle required 30° | 9,937852 |

## CASE V.

*The hypothenuſe and perpendicular being given, to find the acute angles, and alſo the baſe.*




The hypothenuſe is 30.
The perpendicular 15.
ABC a right angle.

To

*To find the angle at* A, *work thus:*

As the log. of the hypothenuſe AC 30 1,477121
to the radius 10,000000
So is the log. of the perpendicular CB 15 1,176091

to the ſine of the angle at A 30° 9,698970

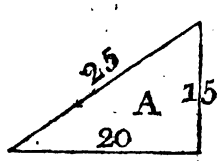
*To find the angle at* C, *work thus:*

As the logarithm of the hypothenuſe AC 30
is to the radius or ſine of 90°.
So is the logarithm of the perpendicular BC 15
to the co-ſine of the angle A, or the right ſine of the angle C 60°.

To find the baſe, work as you were taught in *Caſe* 2.

Here note, that any two ſides of a right-angled triangle being given, the third ſide may be found by extraction of the ſquare root.

EXAMPLE.




In the right-angled triangle A, let the given baſe be 20, the perpendicular 15, and the hypothenuſe required.

The ſquare of the baſe 20, or 20 multiplied by itſelf, is 400: ſquare alſo the perpendicular 15, it gives 225; add theſe ſquares together, and we have 625; the ſquare root of this

this ſum, *viz.* 20, is the length of the hypothenuſe; but if the hypothenuſe and either of the other ſides be given to find the third, you muſt ſubtract the leſs ſquare out of the greater, and the ſquare root of the remainder is the ſide required. As for example; ſuppoſe the hypothenuſe 25 and the baſe 20, to find the perpendicular multiply the hypothenuſe by itſelf, the product is 625
multiply the baſe by itſelf, it makes 400

Subtract 400 from 625, there remains 225

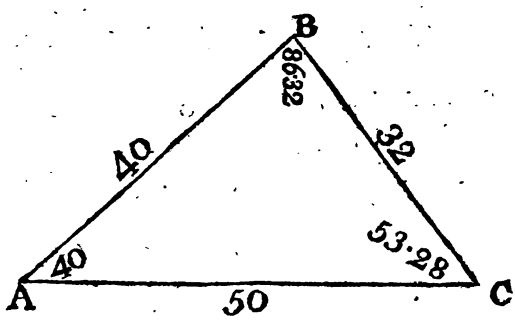
The root of which is 15, the perpendicular required.

20
625(25
45

## CASE VI.

### *Of oblique-angled plane triangles.*

Two ſides of an oblique triangle being given, and an angle oppoſite to either of the ſides, to find the other angles, and alſo the third ſide.




In

In the triangle ABC there is given the ſide AB 40, the ſide BC 32;
The angle at A 40 degrees,
Required the angle at C.

*Note*, that in all oblique triangles the ſides are in ſuch proportion one to another, as the ſines of their oppoſite angles.

| | |
|---|---|
| As the logarithm of the ſide BC 32 | 1,505150 |
| is to the ſine of the angle A 40 | 9,808067 |
| So is the logarithm of the ſide AB 40 | 1,602060 |
| | 11,410127 |
| To the ſine of the angle at C 53°. 28′: | 9,904977 |

*To find the angle at* B.

Add the two known angles together, *viz.* that at A 40, and that at C 53,28, and they make 93 degrees, 28 minutes; which ſubtracted from 180 degrees, leaves 86 degrees, 32 minutes, for the angle at B.

*Laſtly, to find the line* AC, *ſay*,

| | |
|---|---|
| As the ſine of the angle A 40 | 9,808067 |
| is to the logarithm of the ſide BC 32 | 1,505150 |
| So is the ſine of the angle 86°: 32 | 9,999204 |
| | 11,504354 |
| to the log. of the ſide AC required 50 | 1,696287 |

*Note*,

*Note*, the neareſt whole number anſwering to the logarithm 1,696287 is 50; but if you admit fractions, the length of the line AC will be only 49 $\frac{69}{100}$.

## CASE VII.

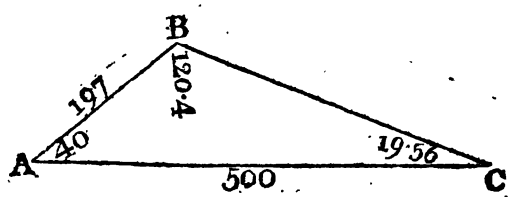
*Two angles being given, and a ſide oppoſite to one of them, to find the other oppoſite ſide.*

In the foregoing triangle there is given the angle A 40 degrees, the angle C 53 degrees, 28 minutes; and the ſide AB 40, to find the ſide BC.

| | |
|---|---|
| As the ſine of the angle C 53 : 28 | 9,904992 |
| is to the log. of the ſide AB 40 | 1,602060 |
| So is the ſine of the angle A 40 | 9,808067 |
| | 11,410127 |
| to the log. of the ſide BC, 32 nearly | 1,505135 |

## CASE VIII.

*Two ſides and the contained angle of a triangle being given, to find either of the other angles.*




In

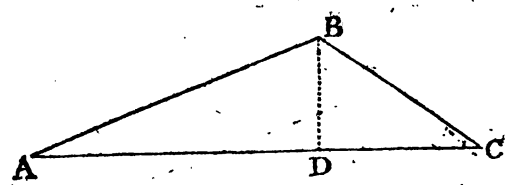
In the triangle ABC
there is given the ſide AB 197,
The ſide AC 500,
The angle at A 40°
To find either of the other angles

| | | |
|---|---|---|
| As the log. of the ſum of the two ſides | 627 | 2,843233 |
| is to the log. of their difference | 303 | 2,481443 |
| So is the tang. of the half ſum of the two oppoſite angles 70 degrees | | 10,438934 |
| | | 12,920377 |
| to the tangent of half their difference 50 degr. 4 min. | | 10,077144 |

Which 50°. 4′, added to the half ſum of the two unknown angles, *viz.* 70°. gives 120°. 4′. for the quantity of the angle at B; but taken from 70, leaves 19°. 56′. the angle at C.

## CASE IX.

*The ſides of an oblique triangle being given, to find the angles.*




You muſt divide your oblique triangle into two right-angled triangles, thus:

In

In the triangle ABC

| | | |
|---|---|---|
| The ſide AC is | | 50 |
| The ſide AB | | 36 |
| The ſide BC | | 20 |
| The ſum of the two ſides AB, BC | | 56 |
| Their difference | | 16 |
| As the log. of the ſide AC 50 | | 1,698970 |
| is to the log. of the ſum of the other two ſides 56 | | 1,748188 |
| So is their diff. | 16 | 1,204120 |
| | | 2,952308 |
| to the log. of a fourth number | 18 | 1,253338 |

Subtract this 18 out of the greateſt ſide AC 50, and there remains 32; the half of which, *viz.* 16, is the baſe of the right-angled triangle BDC, and the remainder of the line AC, *viz.* AD 34, is the baſe of the remaining right-angled triangle, BDA.

Now in each of theſe right-angled triangles, having the baſe and hypothenuſe given, you may find the angles; by *Caſe* IV.

*Note*, It is eaſier to find the 4th number, for dividing an oblique-angled triangle into two right-angled triangles by vulgar arithmetic, than by the tables of logarithms, thus:

Square the three given ſides, add the two greater ſquares together, and from that ſum ſubtract the leſſer; half the remainder divide by the greater ſide, the quotient will be the baſe of the greater right-angled triangle.

## EXAMPLE.

| | |
|---|---|
| In the foregoing triangle, the ſquare of the greateſt ſide AC 50, is | 2500 |
| The ſquare of the ſide AB 36, is | 1296 |
| Added together, make | 3796 |
| From which ſubtract the ſquare of the leaſt ſide | 400 |
| Remains | 3396 |
| The half | 1698 |

Which 1698 divide by 50 the longeſt ſide, the quotient is $33\frac{2}{50}$, the baſe of the greater right-angled triangle, *viz.* AD; and that being ſubtracted from 50, leaves $16\frac{2}{50}$ for the baſe DC of the leſſer right-angled triangle.

CASE

## CASE X.

*The three ſides of an oblique triangle being given, how to find the ſuperficial content, without knowing the perpendicular.*

From half the ſum of the three ſides ſubtract each particular ſide. Add the logarithms of the three differences, alſo the logarithm of half the ſum of the three ſides together. Half the total is the logarithm of the content required.

In the foregoing triangle, the ſides are 50, 36, 20, their ſum is 106; the half ſum 53.

The differences between the half ſum and each particular ſide, are

| | | |
|---|---|---|
| | 3 | log. 0.477121 |
| | 17. | 1.230449 |
| | 33 | 1.518514 |
| The half ſum | 53 | 1.724276 |
| Total added | | 4.950360 |
| The half | | 2.475180 |

The number anſwering to that log. is 298, which is the content of the triangle required.

*By vulgar arithmetic thus:*

Multiply the firſt difference by the ſecond, that product by the third, that product by the half ſum. Laſtly, Extract the ſquare root, and you

have the ſuperficial content. So 3 multiplied by 17, makes 51; which multiplied by 33, makes 1683; that, multiplied by 53, the half ſum makes 89199; the ſquare root of which is 298, the content required.

## CHAP. XIII.

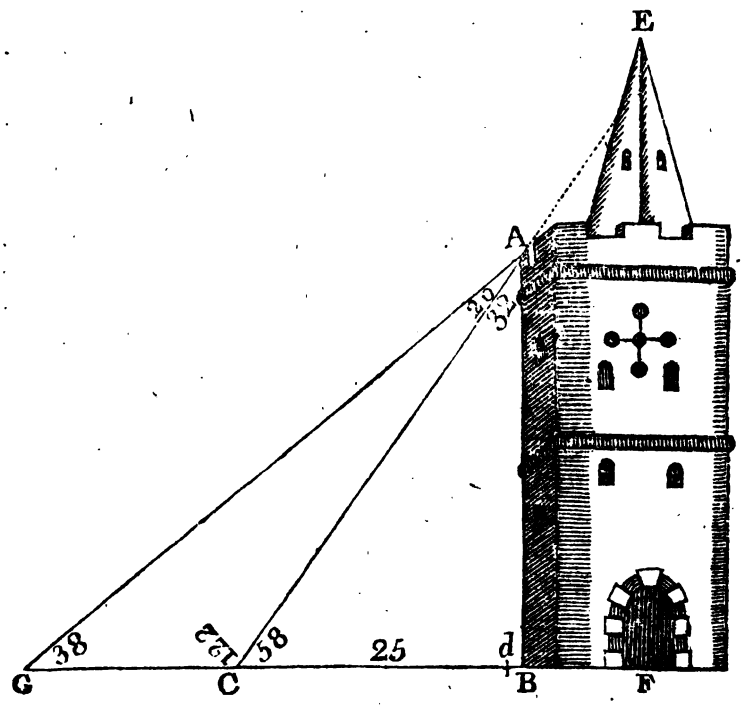
### *Of Heights and Diſtances.*

*To take the height of a tower, ſteeple, tree, or any ſuch thing.*

LET AB be a tower whoſe height you would know.

Firſt, At any convenient diſtance, as at C, place your ſemicircle, or ſuch other inſtrument you judge moſt fit for the taking an angle of altitude, as a large quadrant or the like, and there obſerve the angle ACB. But to be more plain, place your ſemicircle horizontally at C, by making a plummet-line fixed to the center fall juſt upon 90 deg. (in ſome ſemicircles there is a line on the back ſide of the braſs limb, on purpoſe for the ſetting it horizontal.) Then, (firſt ſcrewing the inſtrument faſt) move the index up and down, till through the ſights you eſpy the top of the tower at A, ſee then what degree upon the limb is cut by

by the index, ſuppoſe 58, ſo much is your angle of altitude. Meaſure next the diſtance C *d*, between your inſtrument and the foot of the tower,




which let be 25 yards; then have you all the angles known, (admitting the angle the tower makes with the ground, *viz. d* to be a right angle) and the baſe to find the perpendicular AB; which you may do, by *Caſe* I. of *Trigonometry*; thus,

| | |
|---|---|
| As the ſine of the angle A at 32 | 9,724210 |
| is to the log. of the baſe C *d* 25 | 1,397940 |
| So is the ſine of the angle at C 58 | 9,928420 |
| to the log. height of the tower A B, or rather A *d*, 40 yards | 11,326360 |
| | 1,602150 |

To this 40 yards you muſt add the height of your inſtrument from the ground; or, which is better, look through your fixed ſight to the tower, and mark the point where your ſight falls thereon, meaſure from that point to the ground, and add that diſtance to the former height. In this way of taking heights, the ground ſhould be very level, otherwiſe you may be liable to error. The tower or tree ſhould alſo ſtand perpendicular: or elſe you muſt meaſure to where a perpendicular would interſect the ground thus: If A *d* is the perpendicular, you muſt meaſure the diſtance C *d* for your baſe.

This you may plainly underſtand by the foregoing figure; for if ſtanding at C, you were to take the height of the tower and ſteeple to E, the angle ECB would be the ſame as the angle at ACB; and conſequently, if you meaſure only CB, or C *d*, you will make the height FE the ſame as *d*A; which by the figure is manifeſtly wrong: therefore to take the height FE, you muſt meaſure from C to F.

*To take the height of a tower, &c. when you cannot come near the foot thereof.*

In the foregoing figure, let AB repreſent the tower; and CB a moat, or ſome other hindrance, that you cannot come nigher than C to take the height. Therefore at C place your inſtrument, and take (as before) the angle ACB 58 deg. Then go backward any convenient diſtance, as to G; there alſo take the angle AGB 38 deg. This done ſubtract 58 from 180, ſo have you 122 deg. the angle ACG. Then 122 and 38 being taken from 180, remain 20 for the angle GAC. The diſtance GC meaſured, is 26. Now by *Trigonometry* ſay,

| | |
|---|---|
| As the ſine of the angle A 20 | 9,534052 |
| is to the log. of the diſtance GC 26 | 1,414973 |
| So is the ſine of the angle G 38 | 9,789342 |
| | 11,204315 |
| to the log. of the line AC 47 | 1,670263 |

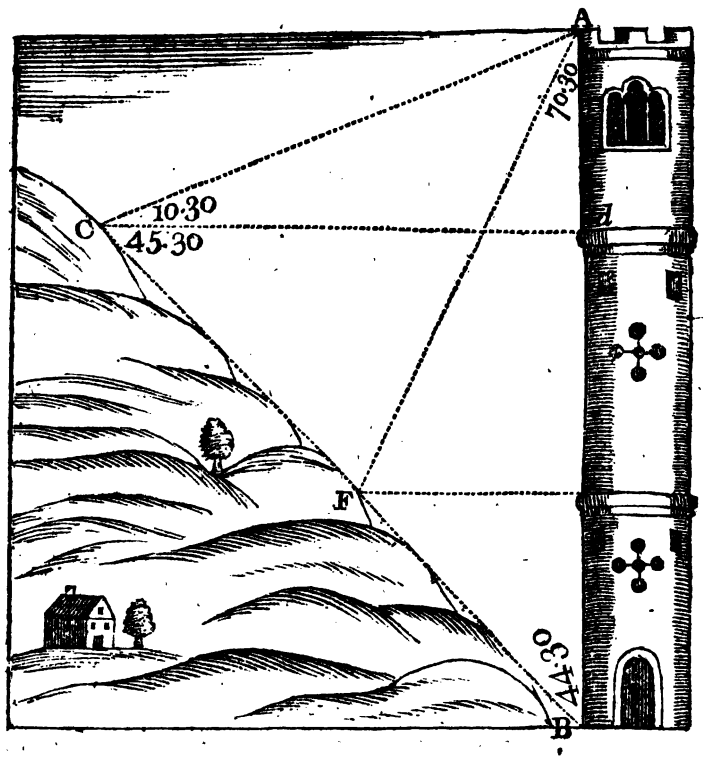
Again,

| | |
|---|---|
| As radius the right angle B | 10,000000 |
| is to the log. of the line AC 47 | 1,4672098 |
| So is the ſine of the angle C 58 | 9,928420 |
| to the log. height of the tower 40 yards | 11,600518 |

In this example, the ground is underſtood to be level. However, if it be not ſo, I will ſhew you,

*How to take the height of a tower, &c. when the ground either riſeth or falleth.*

AB is the tower, CB the hill whereon you are ſtationed to take the height of the tower; plant




your ſemicircle in any place of the hill, as at C; then turn it down, and make it ſtand horizontal, as before directed, the diameter then pointing to *d* of the

the tower, turn the moveable index to A, and take the angle A C *d*; which let be 19 degrees, 30 minutes. Take alſo the angle *d* C B, which is 45 degrees, 30 minutes; meaſure alſo the diſtance C B 56 yards; take 19 degrees, 30 minutes, out of 90 degrees, 0 minutes, there remains 70 degrees, 30 minutes, for the angle at A; then ſay,

| | |
|---|---|
| As ſine 70° 30′ | 9,974346 |
| is to the diſtance C B 56 yards, log. | 1,748188 |
| So is the ſum of the angles at C 19 30, and 45 30, *viz.* 65° 0′ ſine | 9,957276 |
| | 11,705464 |
| to the height of the tower 54 yards, log. | 1,731118 |

To take this at two ſtations, without approaching the foot of the tower, you muſt proceed as before directed; for if you take the angles at C, and then meaſure to F, and there in like manner as before, take your angles again, thereby you may find all the angles, and the line A F; then ſay,

As the ſine of the angle A B F
is to the logarithm of the line F A,
So is the ſine of the angle A F B
to the log. of the height of the tower A B.

## *Of Diſtance.*

Having before ſhewed how to take the proper diſtances in ſurveying a field at two ſtations, yet as it naturally occurs in this place, I will give you one example thereof: ſuppoſe the following figure

to

to be part of a river, and you being meaſuring along one ſide of it, all deſirous to know the breadth of it, as alſo to make a true plot thereof, by putting down what remarkable things are ſeen on the other ſide.

Beginning at ⊙ 1, the firſt ſtation, cauſe one of your aſſiſtants to go to the next bend of the river, at ⊙ 2, and there ſet up a mark; then obſerve what angle from the meridian ⊙ 1, ⊙ 2 makes, which let be N. 6 deg. W.: alſo ſeeing ſeveral marks on the other ſide of the river, take their bearings, as the houſe A, which ſtands upon the bank, the breadth of the river bears N. W. 52 deg. the wind-mill B up in the land bears N. W. 40 deg. the tree C by the water-ſide bears N. W. 17 deg. All this note down in your field-book, and meaſure the diſtance ⊙ 1, ⊙ 2, 18 chains, 20 links. After this, coming to ⊙ 2, ſee how the next bend of the river bears from you, *viz.* ⊙ 3; which is N. E. 15 deg. ſee alſo how the houſe A there bears from you, *viz.* S. W. 20 deg. the wind-mill S. W. 50 deg. the tree N. W. 77. Alſo as you are going forward, if you ſee any thing more at this ſecond ſtation, taking the bearing thereof, as a noted houſe D up in the land bears N. W. 28°. and a church E cloſe by the river's brink N. W. 4°. Meaſure the diſtance 2, 3, and placing your inſtrument at 3, the church bears from you N. W. 88 deg. the houſe up in the land D you cannot ſee for the church, therefore let it alone for the next ſtation. But here you may ſee forward a little village F, the firſt houſe whereof bears from you N. W. 32 deg. Meaſure the diſtance 3, 4, and planting your inſtrument in 4, the firſt houſe of the village F bears from you S. W. 30

S
1
A
B
2
C
3
E
D
F
4
N

deg. and the houſe 32 deg. and the houſe D, which you could not ſee at the third ſtation, S. W. 24°. Having put down all theſe things in your field-book, it will appear thus:

⊙ 1 N. W. 6°. and 18 chains, 20 links, equal to ⊙ 2.

Obſervation. { A tree upon the brink of the river bears N. W. 17°. 00′. / A wind-mill up in the land N. W. 40°. 00′. / A houſe upon the river bank N. W. 52°. 00′. }

⊙ 2. N. E. 15°. and 18 chains, 10 links, equal to ⊙ 3.

{ The tree N. W. 77°. / The houſe S. W. 20°. / The wind-mill S. W. 50°. } Theſe look back to the obſervation of ⊙ 1.

{ A noted houſe far up in the land N. W. 28°. / A church upon the river's bank N. W. 40°. } Forward obſervations.

⊙ 3 N. W. 15°. and 20 chains, 50 links, equal to ⊙ 4.

{ The church bears N. W. 88°. / the noted H. cannot be ſeen. } Theſe look back to the obſ. of ⊙ 2.

{ The end of a little village. N. W. 32. } A forward obſervation.

⊙ 4———

{ The end of the little village. S. W. 32. / The houſe reſpecting ⊙ 2 in the land S. W. 24°. } Theſe reſpect ⊙ 3 and ⊙ 2.

To protract this, draw the line N. S. for a meridian, and laying your protractor upon it, the center thereof to ⊙ 1; againſt N. W. 6°. make a mark

a mark for the line that goes to ⊙ 2: alſo againſt N. W. 17°. make a mark for the tree, and againſt 40°, and 52°. for the windmill and houſe. Then from ⊙ 1 through theſe marks, draw the lines ⊙ A, ⊙ B, ⊙ C, ⊙ 2.

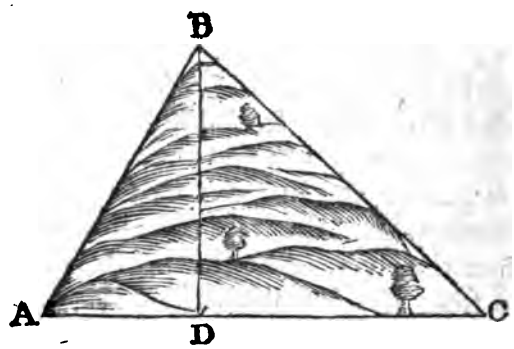
Secondly, Take from your ſcale 18 ch. 20 lin. and ſet it off upon the line ⊙ 2, which will reach from ⊙ to 2. There lay again the center of your protractor, the diameter thereof parallel to the line N. S; and make marks as you ſee in the field-book, againſt N. E. 15°. N. W. 77°. S. W. 20°. S. W. 50°. N. W. 28°. N. W. 4°. and through theſe marks draw lines. The firſt line directs to your third ſtation, the ſecond line N. W. 70°. directs you to the tree C upon the river's bank; for that line cutting the line ⊙ 1 C, ſhews you by the interſection where the tree ſtood, and alſo the breadth of the river. Alſo the line S. W. 20°. cuts the line from the firſt ſtation. N. W. 52°. in the place where the houſe A ſtands upon the bank of the river. If therefore you draw a line from A to C, it will repreſent the farther bank of the river. And ſo you may proceed on plotting, according to the notes in your field-book; and you will not only have a true plot of the river, but alſo know how far the wind-mill B, and the houſe D, &c. ſtand from the water-ſide.

### *How to take the horizontal line of a hill.*

When you meaſure a hill, you muſt meaſure the ſuperficies thereof, and accordingly caſt up the contents. But when you plot it down, becauſe you cannot make a convex ſuperficies upon the paper, you muſt only plot the horizontal or baſe thereof;

thereof; which you muſt ſhadow over with the reſemblance of a hill, that other ſurveyors, when examining your work, may not ſay you were miſtaken. This horizontal or baſe line, you may find after the ſame manner as you have been taught in taking heights.

For ſuppoſe ABCA a hill, whoſe baſe you would know. Place your ſemicircle at A, and cauſe a mark to be ſet up at B, as high above the top of




the hill, as the inſtrument ſtands from the ground at A; and with your inſtrument horizontal, take the angle BAC 58 deg. Meaſure the diſtance AB 16 chains, 80 links; then ſay,

| | |
|---|---|
| As radius | 10,000000 |
| is to the line AB 16 ch. 80 lin. | 3,225309 |
| So is the ſine complement of A 58° | 9,724210 |
| to AD (made by the perpendicular BD) 8 ch. 90 lin. | 12,949519 |

But if you have occaſion to meaſure the whole hill, place again your inſtrument at B, and take the angle CBD, which ſuppoſe 46 deg. Meaſure alſo the diſtance BC 21 chains; then ſay,

As

| | |
|---|---|
| As Radius | 10,000000 |
| is to the line BC 21 ch. (log.) | 1,322219 |
| So is the ſine of the angle CBD 46 | 9,856934 |
| to the remaining part of the baſe DC 15 ch. 11 l. | 11,179153 |

Which added to 8.90 makes 24 chains, 1 link, for the whole baſe AC; which is to be plotted, inſtead of AB or BC; although they were uſed in finding the content of the land.

I mentioned this way, for your better underſtanding how to take the baſe of part of a hill; for it often happens your ſurvey ends upon the ſide of a hill. But if you find you are to take in the whole hill, you may facilitate the work by the former way. Thus: take, as before, the angle at A 58 deg. Meaſure alſo AB. Then at B take the whole angle ABC 78 deg. Subtract the ſum of theſe angles from 180 deg. remains 44 for the angle at C; then ſay,

As the ſine of the angle C
is to the log. of the ſide AB,
So is the ſine of the angle ABC
to the log. of the baſe AC.

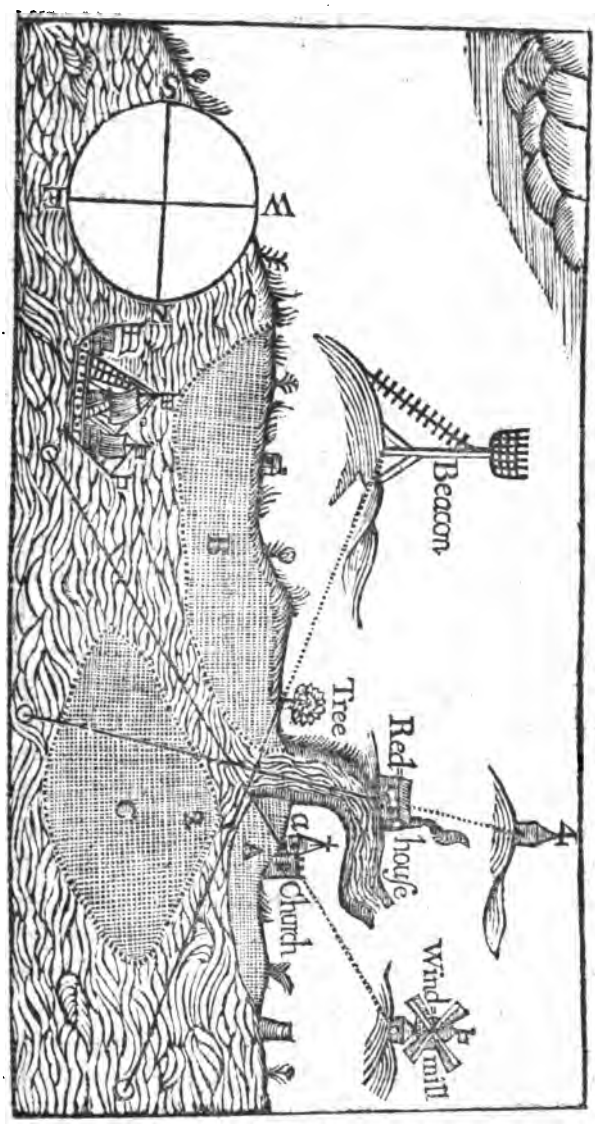
*To take the ſhoals of a river's mouth, and plot the ſame.*

Meaſure firſt the ſea-coaſt on both ſides of the river's mouth, as far as you think you ſhall have occaſion to make uſe thereof; and make a fair draught thereof, putting down every remarkable thing in it's true ſituation, as trees, houſes, towns, wind-mills, *&c.* Then going out in a boat to ſuch

ſuch ſands or rocks as make the entrance difficult, at every conſiderable bend of the ſands, take with a ſea-compaſs the bearing thereof to two known marks upon the ſhore; and having thus ſurveyed round all the ſands and rocks, you may eaſily, upon the plot before taken, draw lines which ſhall interſect each other at every conſiderable point of the ſands, whereby you may truly point out the ſands, and give directions either for laying buoys, or making marks upon the ſhore for the direction of ſhipping.

## EXAMPLE.

Suppoſe the following figure repreſent a part of ſome ſea-coaſt. Firſt, I make a fair draught of it, with the mouth of the river as far up as there is occaſion, putting down every thing remarkable as you ſee in the figure, except the rocks and ſand, which I ſhall now ſhew you how to take. Go in a boat down the river, till you find the beginning of the firſt ſand A as at *a*, and there take a ſight to the red houſe, which bears S. W. 86 deg. alſo to the tree, which lies S. E. 6 deg. To plot which, draw lines in oppoſite directions to your obſervations; as from the red houſe draw a line N. E. 86, and from the tree a line N. W. 6 deg. thoſe lines will interſect each other in the point *a*, which ſhews the beginning of the ſand A. Row along this ſand, ſounding as you go, till you find it bends conſiderably, and there take again two obſervations, and protract them as before. The like do at the bending of every ſand, till either you come round




round the ſand or come to the place where it joins with the ſhore.

It would be needleſs to give you all the remaining obſervations, having already in this treatiſe ſo often deſcribed the manner of making them; therefore I will mention only one place of obſervation more, which I judge ſufficient. In the ſand C, I find the bend (2), and there, as I ſhould do at all the reſt, I take two obſervations to ſuch things on the ſhore as appear moſt conſpicuous, *viz.* firſt, to the beacon, which bears from me S. W. 25 deg. ſecondly to the wind-mill, which bears from me N. W. 40 deg. Now after I have taken the other angles at the bends of that ſand, and am come home, I draw a line from the beacon oppoſite to my obſervations S. W. 25 deg. viz. N. E. 25 deg. Alſo from the wind-mill I draw a line S. E. 40 deg. Now where theſe two lines interſect each other, as at 2, I mark for one point of the ſand C. In like manner as I did this, I obſerve and protract every other line of the ſand C, and of all the other ſands and rocks, ſo will you have a fair map, fitting for ſeamen's uſe.

Now to give directions for ſeamen's coming in here, draw a line through the middle of the ſouth channel; which line will cut both the church and wind-mill; ſo that if a ſhip be coming from the ſouthward, bring the church and wind-mill both into one, and keep them ſo, then ſhe may ſafely run in, till ſhe brings the river's mouth fair open, and then ſail up the river. Likewiſe if coming from the northward, bring the tree and beacon both into one line, and keep them ſo till the river's mouth is fair open. But leſt they ſhould miſtake, and run upon the ends of the ſands A or B, it would be neceſſary that a mark was ſet up behind the red-houſe, in a ſtrait line with the middle of the river, as ⅄.

Then

Then a ſhip coming from the ſouthward, or northward, muſt keep her former marks both in one, 'till ſhe bring the red-houſe and ⛪ both in one line; and keeping them ſo, ſhe may run boldly up the river, 'till all danger is paſt. I have put down this wind-mill and beacon, not as if ſuch good marks would always happen; but to ſhew you how to place marks, or lay buoys if it be required.

You muſt, after having taken all the ſands, alſo take the ſounding quite croſs the channels, all up and down, and put them down accordingly; the beſt time of which, is at low-water in ſpring-tides.

*To know whether water may be made to run from a ſpring-head to any appointed place.*

For this work, the diameter of the ſemicircle is a little too ſhort; however, an indifferent ſhift may be made therewith; but it is better to get a water-level, ſuch as you may buy at the inſtrument-makers; with which being provided, as alſo with two aſſiſtants, and each of them with a ſtaff divided into feet, inches, and parts of an inch, go to the ſpring-head; and cauſing your firſt aſſiſtant to ſtand there with his ſtaff perpendicular, make the other go in a right line towards the place deſigned for bringing the water any convenient diſtance, as 100, 150, or 200 yards, and there let him ſtand, and hold his ſtaff perpendicular alſo. Then ſet your inſtrument nigh the mid-way between 'em, making it ſtand level or horizontal; and look through the ſights thereof to your firſt aſſiſtant's ſtaff, he moving a piece of white paper up and down the ſtaff, according to the ſigns you make to him, 'till through the ſights you ſee juſt the edge of the paper. Then by a ſign give him

to underſtand that you have done with him; and let him write it down how many feet, inches, and parts the paper reſted upon. Alſo going to the other end of your level, do the ſame by the ſecond aſſiſtant, and let him alſo write down what number of feet, *&c.* the paper was from the ground. This done, let your firſt aſſiſtant come to the ſecond aſſiſtant's place, and there let him again ſtand with his ſtaff; and let the ſecond aſſiſtant go forward 100, or 200 yards as before; and placing yourſelf and inſtrument in the midſt between them, take your obſervations altogether as before, and let them be put down as before. And ſo muſt you do till you come to the place to which the water is to be conveyed. Then examine the notes of both your aſſiſtants, and if the notes of the ſecond aſſiſtant exceed thoſe of the firſt, you may be ſure the place is lower than the ſpring-head, and that therefore water may be conveyed thence. But if the firſt's notes exceed the ſecond's, you may conclude it impoſſible, without being raiſed by ſome engine for that purpoſe.

| The firſt Aſſiſtant's Note. | | | | |
|---|---|---|---|---|
| Stat. | | Feet. | Inch. | Parts. |
| ☉ | 1 | 4 | 3 | 5 |
| ☾ | 2 | 12 | 4 | 2 |
| ☉ | 3 | 3 | 5 | 1 |
| | | 20 | 0 | 8 |

| The ſecond Aſſiſtant's Note. | | | | |
|---|---|---|---|---|
| Stat. | | Feet. | Inch. | Parts. |
| ☉ | 1 | 14 | 5 | 1 |
| ☉ | 2 | 4 | 6 | 3 |
| ☉ | 3 | 9 | 2 | 4 |
| | | 28 | 1 | 8 |

Here the ſecond aſſiſtant's note exceeds the firſt, 8 feet 1 inch; which is enough to bring the water with a ſtrong current, and to make it alſo riſe up 6 or 7 feet in the houſe, if occaſion be; for ſuch as have written of this matter, allow but 4 inches and $\frac{1}{2}$ fall in a mile to make the water run.

A

# TABLE

OF THE

Northing or Southing, Eaſting or Weſting, of every Degree from the Meridian, according to the Number of Chains run upon any DEGREE.

## *A Table of Northing or Southing.*

| | 1 Deg. | | | 2 Deg. | | | 3 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N | S | EW | N | S | EW | N | S | EW |
| 1 | 1.0 | | .0 | 1.0 | | .0 | 1.0 | | .1 |
| 2 | 2.0 | | .0 | 2.0 | | .1 | 2.0 | | .1 |
| 3 | 3.0 | | .0 | 3.0 | | .1 | 3.0 | | .1 |
| 4 | 4.0 | | .1 | 4.0 | | .1 | 4.0 | | .2 |
| 5 | 5.0 | | .1 | 5.0 | | .2 | 5.0 | | .2 |
| 6 | 6.0 | | .1 | 6.0 | | .2 | 6.0 | | .3 |
| 7 | 7.0 | | .1 | 7.0 | | .2 | 7.0 | | .4 |
| 8 | 8.0 | | .1 | 8.0 | | .3 | 8.0 | | .4 |
| 9 | 9.0 | | .2 | 9.0 | | .3 | 9.0 | | .5 |
| 10 | 10.0 | | .2 | 10.0 | | .3 | 10.0 | | .5 |
| 20 | 20.0 | | .4 | 20.0 | | .7 | 20.0 | | 1.0 |
| 30 | 30.0 | | .5 | 30.0 | | 1.0 | 30.0 | | 1.6 |
| 40 | 40.0 | | .7 | 40.0 | | 1.4 | 40.0 | | 2.1 |
| 50 | 50.0 | | .9 | 50.0 | | 1.7 | 50.0 | | 2.6 |
| 60 | 60.0 | | 1.1 | 60.0 | | 2.1 | 59.9 | | 3.1 |
| 70 | 70.0 | | 1.2 | 70.0 | | 2.4 | 69.9 | | 3.7 |
| 80 | 80.0 | | 1.4 | 80.0 | | 2.8 | 79.9 | | 4.2 |
| 90 | 90.0 | | 1.6 | 89.9 | | 3.1 | 89.9 | | 4.7 |
| 100 | 100.0 | | 1.8 | 99.9 | | 3.5 | 99.9 | | 5.2 |
| Dist. | E | W | N S | Dist. | EW | N S | Dist. | EW | N S |
| | 89 Deg. | | | | 88 Deg. | | | 87 Deg. | |

*Easting or Westing.*

| | 4 Deg. | | | 5 Deg. | | | 6 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | EW | Distance. | N S | EW | Distance. | N S | EW |
| 1 | 1.0 | .1 | 1 | 1.0 | .1 | 1 | 1.0 | .1 |
| 2 | 2.0 | .1 | 2 | 2.0 | .2 | 2 | 2.0 | .2 |
| 3 | 3.0 | .2 | 3 | 3.0 | .3 | 3 | 3.0 | .3 |
| 4 | 4.0 | .3 | 4 | 4.0 | .3 | 4 | 4.0 | .4 |
| 5 | 5.0 | .3 | 5 | 5.0 | .4 | 5 | 5.0 | .5 |
| 6 | 6.0 | .4 | 6 | 6.0 | .5 | 6 | 6.0 | .6 |
| 7 | 7.0 | .5 | 7 | 7.0 | .6 | 7 | 7.0 | .7 |
| 8 | 8.0 | .6 | 8 | 8.0 | .7 | 8 | 8.0 | .8 |
| 9 | 9.0 | .6 | 9 | 9.0 | .8 | 9 | 8.9 | .9 |
| 10 | 10.0 | .7 | 10 | 10.0 | .9 | 10 | 9.9 | 1.0 |
| 20 | 20.0 | 1.4 | 20 | 20.0 | 1.7 | 20 | 19.9 | 2.1 |
| 30 | 29.9 | 2.1 | 30 | 29.9 | 2.6 | 30 | 29.8 | 3.1 |
| 40 | 39.9 | 2.8 | 40 | 39.8 | 3.5 | 40 | 39.8 | 4.2 |
| 50 | 49.9 | 3.5 | 50 | 49.8 | 4.4 | 50 | 49.7 | 5.2 |
| 60 | 59.9 | 4.2 | 60 | 59.8 | 5.2 | 60 | 59.7 | 6.3 |
| 70 | 69.8 | 4.9 | 70 | 69.7 | 6.1 | 70 | 69.6 | 7.3 |
| 80 | 79.8 | 5.6 | 80 | 79.7 | 7.0 | 80 | 79.6 | 8.3 |
| 90 | 89.8 | 6.3 | 90 | 89.7 | 7.9 | 90 | 89.5 | 9.4 |
| 100 | 99.8 | 7.0 | 100 | 99.6 | 8.7 | 100 | 99.5 | 10.4 |
| Dist. | EW | N S | Dist. | EW | N S | Dist. | EW | N S |
| | 86 Deg. | | | 85 Deg. | | | 84 Deg. | |

## *A Table of Northing or Southing,*

| | 7 Deg. | | | 8 Deg. | | | 9 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | EW | | Distance. | N S | EW | Distance. | N S | EW |
| 1 | 1.0 | .1 | | 1 | 1.0 | .1 | 1 | 1.0 | .2 |
| 2 | 2.0 | .2 | | 2 | 2.0 | .3 | 2 | 2.0 | .3 |
| 3 | 3.0 | .4 | | 3 | 3.0 | .4 | 3 | 3.0 | .5 |
| 4 | 4.0 | .5 | | 4 | 4.0 | .6 | 4 | 4.0 | .6 |
| 5 | 5.0 | .6 | | 5 | 5.0 | .7 | 5 | 5.0 | 8. |
| 6 | 6.0 | .7 | | 6 | 5.9 | .8 | 6 | 5.9 | .9 |
| 7 | 6.9 | .8 | | 7 | 6.9 | 1.0 | 7 | 6.9 | 1.1 |
| 8 | 7.9 | 1.0 | | 8 | 7.9 | 1.1 | 8 | 7.9 | 1.3 |
| 9 | 8.9 | 1.1 | | 9 | 8.9 | 1.3 | 9 | 8.9 | 1.4 |
| 10 | 9.9 | 1.2 | | 10 | 9.9 | 1.4 | 10 | 9.9 | 1.6 |
| 20 | 19.9 | 2.4 | | 20 | 19.8 | 2.8 | 20 | 19.8 | 3.1 |
| 30 | 29.8 | 3.7 | | 30 | 29.7 | 4.2 | 30 | 29.6 | 4.7 |
| 40 | 39.7 | 4.9 | | 40 | 39.6 | 5.6 | 40 | 39.0 | 6.3 |
| 50 | 49.6 | 6.1 | | 50 | 49.5 | 7.0 | 50 | 49.4 | 7.8 |
| 60 | 59.6 | 7.3 | | 60 | 59.4 | 8.3 | 60 | 59.8 | 9.4 |
| 70 | 69.5 | 8.5 | | 70 | 69.3 | 9.7 | 70 | 69.1 | 10.9 |
| 80 | 79.4 | 9.8 | | 80 | 79.2 | 11.1 | 80 | 79.0 | 12.5 |
| 90 | 89.3 | 11.0 | | 90 | 89.1 | 12.5 | 90 | 88.9 | 14 1 |
| 100 | 99.3 | 12.2 | | 100 | 99.0 | 13.9 | 100 | 98.8 | 15.6 |
| Dift. | E W | N S | | Dift. | EW | N S | Dift. | EW | N S |
| | 83 Deg. | | | | 82 Deg. | | | 81 Deg. | |

*Easting or Westing.*

| Distance. | 10 Deg. N S | 10 Deg. EW | Distance. | 11 Deg. N S | 11 Deg. EW | Distance. | 12 Deg. N S | 12 Deg. EW |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | .2 | 1 | 1.0 | .2 | 1 | 1.0 | .2 |
| 2 | 2.0 | .3 | 2 | 2.0 | .4 | 2 | 2.0 | .4 |
| 3 | 3.0 | .5 | 3 | 2.9 | .6 | 3 | 2.9 | .6 |
| 4 | 3.9 | .7 | 4 | 3.9 | .8 | 4 | 3.9 | .8 |
| 5 | 4.9 | .9 | 5 | 4.9 | .9 | 5 | 4.9 | 1.0 |
| 6 | 5.9 | 1.0 | 6 | 5.9 | 1.1 | 6 | 5.9 | 1.2 |
| 7 | 6.9 | 1.2 | 7 | 6.9 | 1.3 | 7 | 6.9 | 1.5 |
| 8 | 7.9 | 1.4 | 8 | 7.8 | 1.5 | 8 | 7.8 | 1.7 |
| 9 | 8.9 | 1.6 | 9 | 8.8 | 1.7 | 9 | 8.8 | 1.9 |
| 10 | 9.9 | 1.7 | 10 | 9.8 | 1.9 | 10 | 9.8 | 2.1 |
| 20 | 19.7 | 3.5 | 20 | 19.6 | 3.8 | 20 | 19.6 | 4.2 |
| 30 | 29.6 | 5.2 | 30 | 29.4 | 5.7 | 30 | 29.3 | 6.2 |
| 40 | 39.4 | 6.9 | 40 | 39.3 | 7.6 | 40 | 39.1 | 8.3 |
| 50 | 49.2 | 8.7 | 50 | 49.1 | 9.5 | 50 | 48.9 | 10.4 |
| 60 | 59.1 | 10.4 | 60 | 58.9 | 11.4 | 60 | 58.7 | 12.5 |
| 70 | 68.9 | 12.1 | 70 | 68.7 | 13.4 | 70 | 68.5 | 14.6 |
| 80 | 78.8 | 13.9 | 80 | 78.5 | 15.3 | 80 | 78.3 | 16.6 |
| 90 | 88.6 | 15.6 | 90 | 88.3 | 17.2 | 90 | 88.0 | 18.7 |
| 100 | 98.5 | 17.4 | 100 | 98.1 | 19.1 | 100 | 97.8 | 20.8 |
| Dist. | EW | N S | Dist. | EW | N S | Dist. | EW | N S |
| | 80 Deg. | | | 79 Deg. | | | 78 Deg. | |

## *A Table of Northing or Southing.*

| | 13 Deg. | | | 14 Deg. | | | 15 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | E W | | Distance. | N S | E W | Distance. | N S | E W |
| 1 | 1.0 | .2 | | 1 | 1.0 | .2 | 1 | 1.0 | .3 |
| 2 | 2.0 | .4 | | 2 | 1.9 | .5 | 2 | 1.9 | .5 |
| 3 | 2.9 | .7 | | 3 | 2.9 | .7 | 3 | 2.9 | .8 |
| 4 | 3.9 | .9 | | 4 | 3.9 | 1.0 | 4 | 3.9 | 1.0 |
| 5 | 4.9 | 1.1 | | 5 | 4.8 | 1.2 | 5 | 4.8 | 1.3 |
| 6 | 5.9 | 1.3 | | 6 | 5.8 | 1.4 | 6 | 5.8 | 1.6 |
| 7 | 6.8 | 1.6 | | 7 | 6.8 | 1.7 | 7 | 6.8 | 1.8 |
| 8 | 7.8 | 1.8 | | 8 | 7.8 | 1.9 | 8 | 7.7 | 2.1 |
| 9 | 8.8 | 2.0 | | 9 | 8.7 | 2.2 | 9 | 8.7 | 2.3 |
| 10 | 9.8 | 2.2 | | 10 | 9.7 | 2.4 | 10 | 9.7 | 2.6 |
| 20 | 19.5 | 4.5 | | 20 | 19.4 | 4.8 | 20 | 19.3 | 5.2 |
| 30 | 29.2 | 6.7 | | 30 | 29.1 | 7.3 | 30 | 29.0 | 7.8 |
| 40 | 39.0 | 9.0 | | 40 | 38.8 | 9.7 | 40 | 38.6 | 10.3 |
| 50 | 48.7 | 11.2 | | 50 | 48.5 | 12.1 | 50 | 48.3 | 12.9 |
| 60 | 58.5 | 13.5 | | 60 | 58.2 | 14.5 | 60 | 58.0 | 15.5 |
| 70 | 68.2 | 15.7 | | 70 | 67.9 | 16.9 | 70 | 67.6 | 18.1 |
| 80 | 78.0 | 18.0 | | 80 | 77.6 | 19.4 | 80 | 77.3 | 20.7 |
| 90 | 87.7 | 20.2 | | 90 | 87.3 | 21.8 | 90 | 86.9 | 23.3 |
| 100 | 97.4 | 22.5 | | 100 | 97.0 | .2 | 100 | 96.6 | 25.9 |
| Dist. | E W | N S | | Dist. | E W | N S | Dist. | E W | N S |
| | 77 Deg. | | | | 76 Deg. | | | 75 Deg. | |

*Easting or Westing.*

| Distance. | 16 Deg. N S | 16 Deg. EW | Distance. | 17 Deg. N S | 17 Deg. EW | Distance. | 18 Deg. N S | 18 Deg. EW |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | .3 | 1 | 1.0 | .3 | 1 | 1.0 | .3 |
| 2 | 1.9 | .6 | 2 | 1.9 | .6 | 2 | 1.9 | .6 |
| 3 | 2.9 | .8 | 3 | 2.9 | .9 | 3 | 2.8 | .9 |
| 4 | 3.8 | 1.1 | 4 | 3.8 | 1.2 | 4 | 3.8 | 1.2 |
| 5 | 4.8 | 1.4 | 5 | 4.8 | 1.5 | 5 | 4.7 | 1.5 |
| 6 | 5.8 | 1.7 | 6 | 5.7 | 1.7 | 6 | 5.7 | 1.8 |
| 7 | 6.7 | 1.9 | 7 | 6.7 | 2.0 | 7 | 6.6 | 2.2 |
| 8 | 7.7 | 2.2 | 8 | 7.6 | 2.3 | 8 | 7.6 | 2.5 |
| 9 | 8.6 | 2.5 | 9 | 8.6 | 2.6 | 9 | 8.5 | 2.8 |
| 10 | 9.6 | 2.8 | 10 | 9.6 | 2.9 | 10 | 9.5 | 3.1 |
| 20 | 19.2 | 5.5 | 20 | 19.1 | 5.8 | 20 | 19.0 | 6.2 |
| 30 | 28.8 | 8.3 | 30 | 28.7 | 8.8 | 30 | 28.5 | 9.3 |
| 40 | 38.4 | 11.0 | 40 | 38.3 | 11.7 | 40 | 38.0 | 12.4 |
| 50 | 48.1 | 13.8 | 50 | 47.8 | 14.6 | 50 | 47.6 | 15.4 |
| 60 | 57.7 | 16.5 | 60 | 57.4 | 17.5 | 60 | 57.1 | 18.5 |
| 70 | 67.3 | 19.3 | 70 | 66.9 | 20.5 | 70 | 66.6 | 21.6 |
| 80 | 76.9 | 22.0 | 80 | 76.5 | 23.4 | 80 | 76.1 | 24.7 |
| 90 | 86.2 | 24.8 | 90 | 86.1 | 26.3 | 90 | 85.6 | 27.8 |
| 100 | 96.1 | 27.6 | 100 | 95.6 | 29.2 | 100 | 95.1 | 30.9 |

| Dist. | EW | N S | Dist. | EW | N S | Dist. | EW | N S |
|---|---|---|---|---|---|---|---|---|
| | 74 Deg. | | | 73 Deg. | | | 72 Deg. | |

## A Table of Northing or Southing

| Distance. | 19 Deg. N S | 19 Deg. E W | Distance. | 20 Deg. N S | 20 Deg. E W | Distance. | 21 Deg. N S | 21 Deg. E W |
|---|---|---|---|---|---|---|---|---|
| 1 | .9 | .3 | 1 | .9 | .3 | 1 | .9 | .4 |
| 2 | 1.9 | .6 | 2 | 1.9 | .7 | 2 | 1.9 | .7 |
| 3 | 2.8 | 1.0 | 3 | 2.8 | 1.0 | 3 | 2.8 | 1.1 |
| 4 | 3.8 | 1.3 | 4 | 3.8 | 1.4 | 4 | 3.7 | 1.4 |
| 5 | 4.7 | 1.6 | 5 | 4.7 | 1.7 | 5 | 4.7 | 1.8 |
| 6 | 5.7 | 2.0 | 6 | 5.6 | 2.0 | 6 | 5.6 | 2.1 |
| 7 | 6.6 | 2.3 | 7 | 6.6 | 2.4 | 7 | 6.5 | 2.5 |
| 8 | 7.5 | 2.6 | 8 | 7.5 | 2.7 | 8 | 7.5 | 2.9 |
| 9 | 8.5 | 2.9 | 9 | 8.5 | 3.1 | 9 | 8.4 | 3.2 |
| 10 | 9.4 | 3.3 | 10 | 9.4 | 3.4 | 10 | 9.3 | 3.6 |
| 20 | 18.9 | 6.5 | 20 | 18.8 | 6.8 | 20 | 18.7 | 7.2 |
| 30 | 28.4 | 9.8 | 30 | 28.2 | 10.3 | 30 | 28.0 | 10.7 |
| 40 | 37.8 | 13.0 | 40 | 37.6 | 13.7 | 40 | 37.3 | 14.3 |
| 50 | 47.3 | 16.3 | 50 | 47.0 | 17.1 | 50 | 46.7 | 17.9 |
| 60 | 56.7 | 19.5 | 60 | 56.4 | 20.5 | 60 | 56.0 | 21.5 |
| 70 | 66.2 | 22.8 | 70 | 65.8 | 23.9 | 70 | 65.3 | 25.1 |
| 80 | 75.6 | 26.1 | 80 | 75.2 | 27.4 | 80 | 74.7 | 28.7 |
| 90 | 85.1 | 29.3 | 90 | 84 6 | 30.8 | 90 | 84.0 | 32.3 |
| 100 | 94.5 | 32.6 | 100 | 94.0 | 34.2 | 100 | 93.4 | 35.8 |
| Dift. | E W | N S | Dift. | E W | N S | Dift. | E W | N S |
| | 71 Deg. | | | 70 Deg. | | | 69 Deg. | |

*Easting or Westing.*

| | 22 Deg. | | | 23 Deg. | | | 24 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | EW | | N S | EW | | N S | EW | |
| 1 | .9 | .4 | 1 | .9 | .4 | 1 | .9 | .4 | |
| 2 | 1.9 | .7 | 2 | 1.8 | .8 | 2 | 1.8 | .8 | |
| 3 | 2.8 | 1.1 | 3 | 2.8 | 1.2 | 3 | 2.7 | 1.2 | |
| 4 | 3.7 | 1.5 | 4 | 3.7 | 1.6 | 4 | 3.6 | 1.6 | |
| 5 | 4.6 | 1.9 | 5 | 4.6 | 1.9 | 5 | 4.6 | 2.0 | |
| 6 | 5.6 | 2.2 | 6 | 5.5 | 2.3 | 6 | 5.5 | 2.4 | |
| 7 | 6.5 | 2.6 | 7 | 6.4 | 2.7 | 7 | 6.4 | 2.8 | |
| 8 | 7.4 | 3.0 | 8 | 7.4 | 3.1 | 8 | 7.3 | 3.2 | |
| 9 | 8.3 | 3.4 | 9 | 8.3 | 3.5 | 9 | 8.2 | 3.7 | |
| 10 | 9.3 | 3.7 | 10 | 9.2 | 3.9 | 10 | 9.1 | 4.1 | |
| 20 | 18.5 | 7.5 | 20 | 18.4 | 7.8 | 20 | 18.3 | 8.1 | |
| 30 | 27.8 | 11.2 | 30 | 27.6 | 11.7 | 30 | 27.4 | 12.2 | |
| 40 | 37.1 | 15.0 | 40 | 36.8 | 15.6 | 40 | 36.5 | 16.3 | |
| 50 | 46.4 | 18.7 | 50 | 46.0 | 19.5 | 50 | 45.7 | 20.3 | |
| 60 | 55.6 | 22 5 | 60 | 55.2 | 23.4 | 60 | 54.8 | 24.4 | |
| 70 | 64.9 | 26.2 | 70 | 64.4 | 27.3 | 70 | 63.9 | 28.5 | |
| 80 | 74.2 | 30.0 | 80 | 73.6 | 31.2 | 80 | 73.1 | 32.5 | |
| 90 | 83.4 | 33.7 | 90 | 82.8 | 35.2 | 90 | 82.2 | 36.6 | |
| 100 | 92.7 | 37.5 | 100 | 92.0 | 39.1 | 100 | 91.3 | 40.7 | |
| Dist. | EW | N S | Dist. | EW | N S | Dist. | EW | N S | |
| | 68 Deg. | | | 67 Deg. | | | 66 Deg. | | |

## A Table of Northing or Southing.

| Distance. | 25 Deg. N | 25 Deg. S | 25 Deg. EW | Distance. | 26 Deg. N | 26 Deg. S | 26 Deg. EW | Distance. | 27 Deg. N | 27 Deg. S | 27 Deg. EW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .9 | | .4 | 1 | .9 | | .4 | 1 | .9 | | .5 |
| 2 | 1.8 | | .8 | 2 | 1.8 | | .9 | 2 | 1.8 | | .9 |
| 3 | 2.7 | | 1.3 | 3 | 2.7 | | 1.3 | 3 | 2.7 | | 1.4 |
| 4 | 3.6 | | 1.7 | 4 | 3.6 | | 1.8 | 4 | 3.6 | | 1.8 |
| 5 | 4.5 | | 2.1 | 5 | 4.5 | | 2.2 | 5 | 4.5 | | 2.3 |
| 6 | 5.4 | | 2.5 | 6 | 5.4 | | 2.6 | 6 | 5.3 | | 2.7 |
| 7 | 6.3 | | 3.0 | 7 | 6.3 | | 3.1 | 7 | 6.2 | | 3.2 |
| 8 | 7.2 | | 3.4 | 8 | 7.2 | | 3.5 | 8 | 7.1 | | 3.6 |
| 9 | 8.1 | | 3.8 | 9 | 8.1 | | 3.9 | 9 | 8.0 | | 4.1 |
| 10 | 9.1 | | 4.2 | 10 | 9.0 | | 4.4 | 10 | 8.9 | | 4.5 |
| 20 | 18.1 | | 8.4 | 20 | 18.0 | | 8.8 | 20 | 17.8 | | 9.1 |
| 30 | 27.2 | | 12.7 | 30 | 27.0 | | 13.1 | 30 | 26.7 | | 13.6 |
| 40 | 36.2 | | 16.9 | 40 | 36.0 | | 17.5 | 40 | 35.6 | | 18.2 |
| 50 | 45.3 | | 21.1 | 50 | 44.9 | | 21.9 | 50 | 44.5 | | 22.7 |
| 60 | 54.4 | | 25.4 | 60 | 53.9 | | 26.3 | 60 | 53.5 | | 27.2 |
| 70 | 63.4 | | 29.6 | 70 | 62.9 | | 30.7 | 70 | 62.4 | | 31.8 |
| 80 | 72.5 | | 33.8 | 80 | 71.9 | | 35.1 | 80 | 71.3 | | 36.3 |
| 90 | 81.6 | | 38.0 | 90 | 80.9 | | 39.4 | 90 | 80.2 | | 40.9 |
| 100 | 90.6 | | 42.3 | 100 | 89.9 | | 43.8 | 100 | 89.1 | | 45.4 |
| Dist. | EW | N | S | Dist. | EW | N | S | Dist. | EW | N | S |
| | 65 Deg. | | | | 64 Deg. | | | | 63 Deg. | | |

*Easting or Westing.*

| | 28 Deg. | | | 29 Deg. | | | 30 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | E W | | N S | E W | | N S | E W | |
| 1 | .9 | .5 | 1 | .9 | .5 | 1 | .9 | .5 | |
| 2 | 1.8 | .9 | 2 | 1.7 | 1.0 | 2 | 1.7 | 1.0 | |
| 3 | 2.6 | 1.4 | 3 | 2.6 | 1.4 | 3 | 2.6 | 1.5 | |
| 4 | 3.5 | 1.9 | 4 | 3.5 | 1.9 | 4 | 3.4 | 2.0 | |
| 5 | 4.4 | 2.3 | 5 | 4.4 | 2.4 | 5 | 4.5 | 2.5 | |
| 6 | 5.3 | 2.8 | 6 | 5.2 | 2.9 | 6 | 5.2 | 3.0 | |
| 7 | 6.2 | 3.3 | 7 | 6.1 | 3.4 | 7 | 6.1 | 3.5 | |
| 8 | 7.1 | 3.7 | 8 | 7.0 | 3.9 | 8 | 6.9 | 4.0 | |
| 9 | 7.9 | 4.2 | 9 | 7.9 | 4.3 | 9 | 7.8 | 4.5 | |
| 10 | 8.8 | 4.7 | 10 | 8.7 | 4.8 | 10 | 8.7 | 5.0 | |
| 20 | 17.7 | 9.4 | 20 | 17.5 | 9.7 | 20 | 17.3 | 10.0 | |
| 30 | 26.5 | 14.1 | 30 | 26.2 | 14.5 | 30 | 26.0 | 15.0 | |
| 40 | 35.3 | 18.8 | 40 | 35.0 | 19.4 | 40 | 34.6 | 20.0 | |
| 50 | 44.1 | 23.5 | 50 | 43.7 | 24.2 | 50 | 43.3 | 25.0 | |
| 60 | 53.0 | 28.2 | 60 | 52.5 | 29.1 | 60 | 52.0 | 30.0 | |
| 70 | 61.8 | 32.9 | 70 | 61.2 | 33.9 | 70 | 60.6 | 35.0 | |
| 80 | 70.6 | 37.6 | 80 | 70.0 | 38.8 | 80 | 69.3 | 40.0 | |
| 90 | 79.5 | 42.2 | 90 | 79.7 | 43.6 | 90 | 77.9 | 45.0 | |
| 100 | 88.3 | 46.9 | 100 | 87.5 | 48.5 | 100 | 86.6 | 50.0 | |
| Dist. | E W | N S | Dist. | E W | N S | Dist. | E W | N S | |
| | 62 Deg. | | | 61 Deg. | | | 60 Deg. | | |

## A Table of Northing or Southing.

| Distance. | 31 Deg. N | S | EW | Distance. | 32 Deg. N | S | EW | Distance. | 33 Deg. N | S | EW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .9 | | 1.5 | 1 | .8 | | .5 | 1 | .8 | | .5 |
| 2 | 1.7 | | 1.0 | 2 | 1.7 | | 1.1 | 2 | 1.7 | | 1.1 |
| 3 | 2.6 | | 1.5 | 3 | 2.5 | | 1.6 | 3 | 2.5 | | 1.6 |
| 4 | 3.4 | | 2.1 | 4 | 3.4 | | 2.1 | 4 | 3.4 | | 2.2 |
| 5 | 4.3 | | 2.6 | 5 | 4.2 | | 2.6 | 5 | 4.2 | | 2.7 |
| 6 | 5.1 | | 3.1 | 6 | 5.1 | | 3.2 | 6 | 5.0 | | 3.3 |
| 7 | 6.0 | | 3.6 | 7 | 5.9 | | 3.7 | 7 | 5.9 | | 3.8 |
| 8 | 6.9 | | 4.1 | 8 | 6.8 | | 4.2 | 8 | 6.7 | | 4.4 |
| 9 | 7.7 | | 4.6 | 9 | 7.6 | | 4.8 | 9 | 7.6 | | 4.9 |
| 10 | 8.6 | | 5.1 | 10 | 8.5 | | 5.3 | 10 | 8.4 | | 5.4 |
| 20 | 17.1 | | 10.3 | 20 | 17.0 | | 10.6 | 20 | 16.8 | | 10.9 |
| 30 | 25.7 | | 15.4 | 30 | 25.4 | | 15.9 | 30 | 25.2 | | 16.3 |
| 40 | 34.3 | | 20.6 | 40 | 33.9 | | 21.2 | 40 | 33.5 | | 21.8 |
| 50 | 32.9 | | 25.7 | 50 | 42.4 | | 26.5 | 50 | 41.9 | | 27.2 |
| 60 | 51.4 | | 30.9 | 60 | 50.9 | | 31.8 | 60 | 50.3 | | 32.7 |
| 70 | 60.0 | | 36.0 | 70 | 59.4 | | 37.1 | 70 | 58.7 | | 38.1 |
| 80 | 68.6 | | 41.2 | 80 | 67.8 | | 42.4 | 80 | 67.1 | | 43.6 |
| 90 | 77.1 | | 46.3 | 90 | 76.3 | | 47.7 | 90 | 75.5 | | 49.0 |
| 100 | 85.7 | | 51.5 | 100 | 84.8 | | 53.0 | 100 | 83.9 | | 54.5 |
| Dist. | EW | N | S | Dist. | EW | N | S | Dist. | EW | N | S |
| | 59 Deg. | | | | 58 Deg. | | | | 57 Deg. | | |

*Easting or Westing.*

| Distance. | 34 Deg. N S | 34 Deg. E W | Distance. | 35 Deg. N S | 35 Deg. E W | Distance. | 36 Deg. N S | 36 Deg. E W |
|---|---|---|---|---|---|---|---|---|
| 1 | .8 | .6 | 1 | .8 | .6 | 1 | .8 | .6 |
| 2 | 1.7 | 1.1 | 2 | 1.7 | 1.1 | 2 | 1.6 | 1.2 |
| 3 | 2.5 | 1.7 | 3 | 2.5 | 1.7 | 3 | 2.4 | 1.8 |
| 4 | 3.3 | 2.2 | 4 | 3.3 | 2.3 | 4 | 3.2 | 2.3 |
| 5 | 4.1 | 2.8 | 5 | 4.1 | 2.9 | 5 | 4.0 | 2.9 |
| 6 | 5.0 | 3.4 | 6 | 4.9 | 3.4 | 6 | 4.8 | 3.5 |
| 7 | 5.8 | 3.9 | 7 | 5.7 | 4.0 | 7 | 5.6 | 4.1 |
| 8 | 6.6 | 4.5 | 8 | 6.6 | 4.6 | 8 | 6.4 | 4.7 |
| 9 | 7.5 | 5.0 | 9 | 7.4 | 5.2 | 9 | 7.2 | 5.3 |
| 10 | 8.3 | 5.6 | 10 | 8.2 | 5.7 | 10 | 8.1 | 5.9 |
| 20 | 16.6 | 11.2 | 20 | 16.4 | 11.5 | 20 | 16.2 | 11.8 |
| 30 | 24.9 | 16.8 | 30 | 24.6 | 17.2 | 30 | 24.3 | 17.6 |
| 40 | 33.2 | 22.4 | 40 | 32.8 | 22.9 | 40 | 32.4 | 23.5 |
| 50 | 41.4 | 28.0 | 50 | 41.0 | 28.7 | 50 | 40.4 | 29.4 |
| 60 | 49.7 | 33.5 | 60 | 49.1 | 34.4 | 60 | 48.5 | 35.3 |
| 70 | 58.0 | 39.1 | 70 | 57.3 | 40.2 | 70 | 56.6 | 41.1 |
| 80 | 66.3 | 44.7 | 80 | 65.5 | 45.9 | 80 | 64.7 | 47.0 |
| 90 | 74.6 | 50.3 | 90 | 73.7 | 51.6 | 90 | 72.8 | 52.9 |
| 100 | 82.9 | 55.9 | 100 | 81.9 | 57.4 | 100 | 80.9 | 58.8 |

| Dist. | 56 Deg. E W | 56 Deg. N S | Dist. | 55 Deg. E W | 55 Deg. N S | Dist. | Deg. E W | Deg. N S |
|---|---|---|---|---|---|---|---|---|

## A Table of Northing or Southing.

| | 37 Deg. | | | 38 Deg. | | | 39 Deg. | | |
|---|---|---|---|---|---|---|---|---|---|
| Distance. | N S | E W | | N S | E W | | N S | E W | |
| 1 | .8 | .6 | 1 | .8 | .6 | 1 | .8 | .6 | |
| 2 | 1.6 | 1.2 | 2 | 1.6 | 1.2 | 2 | 1.6 | 1.3 | |
| 3 | 2.4 | 1.8 | 3 | 2.4 | 1.8 | 3 | 2.3 | 1.9 | |
| 4 | 3.2 | 2.4 | 4 | 3.1 | 2.5 | 4 | 3.1 | 2.5 | |
| 5 | 4.0 | 3.0 | 5 | 3.9 | 3.1 | 5 | 3.9 | 3.1 | |
| 6 | 4.8 | 3.6 | 6 | 4.7 | 3.7 | 6 | 4.7 | 3.8 | |
| 7 | 5.6 | 4.2 | 7 | 5.5 | 4.3 | 7 | 5.4 | 4.4 | |
| 8 | 6.4 | 4.8 | 8 | 6.3 | 4.9 | 8 | 6.2 | 5.0 | |
| 9 | 7.2 | 5.4 | 9 | 7.1 | 5.5 | 9 | 7.0 | 5.7 | |
| 10 | 8.0 | 6.0 | 10 | 7.9 | 6.2 | 10 | 7.8 | 6.3 | |
| 20 | 16.0 | 12.0 | 20 | 15.8 | 12.3 | 20 | 15.5 | 12.6 | |
| 30 | 24.0 | 18.0 | 30 | 23.6 | 18.5 | 30 | 13.3 | 18.9 | |
| 40 | 31.9 | 24.1 | 40 | 31.5 | 24.6 | 40 | 21.1 | 25.2 | |
| 50 | 39.9 | 30.1 | 50 | 39.4 | 20.8 | 50 | 38.8 | 31.5 | |
| 60 | 47.9 | 36.1 | 60 | 47.3 | 36.9 | 60 | 46.6 | 37.8 | |
| 70 | 55.9 | 42.1 | 70 | 55.2 | 43.1 | 70 | 54.4 | 44.0 | |
| 80 | 63.9 | 48.1 | 80 | 63.0 | 49.3 | 80 | 62.2 | 50.3 | |
| 90 | 71.9 | 54.2 | 90 | 70.9 | 55.4 | 90 | 69.9 | 56.6 | |
| 100 | 79.9 | 60.2 | 100 | 78.8 | 61.6 | 100 | 77.7 | 62.9 | |
| Dist. | E W | N S | Dist. | E W | N S | Dist. | E W | N S | |
| | 53 Deg. | | | 52 Deg. | | | 51 Deg. | | |

*Easting or Westing.*

| Distance. | 40 Deg. N S | E W | Distance. | 41 Deg. N S | E W | Distance. | 42 Deg. N S | E W |
|---|---|---|---|---|---|---|---|---|
| 1 | .8 | .6 | 1 | .8 | .7 | 1 | .7 | .7 |
| 2 | 1.5 | 1.3 | 2 | 1.5 | 1.3 | 2 | 1.5 | 1.3 |
| 3 | 2.3 | 1.9 | 3 | 2.3 | 2.0 | 3 | 2.2 | 2.0 |
| 4 | 3.1 | 2.6 | 4 | 3.0 | 2.6 | 4 | 3.0 | 2.7 |
| 5 | 3.8 | 3.2 | 5 | 3.8 | 3.3 | 5 | 3.7 | 3.3 |
| 6 | 4.6 | 3.8 | 6 | 4.5 | 3.9 | 6 | 4.4 | 4.0 |
| 7 | 5.4 | 4.5 | 7 | 5.3 | 4.6 | 7 | 5.2 | 5.7 |
| 8 | 6.1 | 5.1 | 8 | 6.0 | 5.2 | 8 | 5.9 | 5.3 |
| 9 | 6.9 | 5.8 | 9 | 6.8 | 5.9 | 9 | 6.7 | 6.0 |
| 10 | 7.7 | 6.4 | 10 | 7.5 | 6.6 | 10 | 7.4 | 6.7 |
| 20 | 15.3 | 12.9 | 20 | 15.1 | 13.1 | 20 | 14.9 | 13.4 |
| 30 | 23.0 | 19.3 | 30 | 22.6 | 19.7 | 30 | 22.3 | 20.1 |
| 40 | 30.6 | 25.7 | 40 | 30.2 | 26.2 | 40 | 29.7 | 26.8 |
| 50 | 38.3 | 32.1 | 50 | 37.7 | 32.8 | 50 | 37.2 | 33.5 |
| 60 | 46.0 | 38.6 | 60 | 45.3 | 39.4 | 60 | 44.6 | 40.1 |
| 70 | 53.6 | 45.0 | 70 | 52.8 | 45.9 | 70 | 52.0 | 46.8 |
| 80 | 61.3 | 51.4 | 80 | 60.4 | 52.5 | 80 | 59.4 | 53.5 |
| 90 | 68.9 | 57.9 | 90 | 67.9 | 59.0 | 90 | 66.9 | 60.2 |
| 100 | 76.6 | 64.3 | 100 | 75.5 | 65.6 | 100 | 74.3 | 66.9 |

| Dist. | E W | N S | Dist. | E W | N S | Dist. | E W | N S |
|---|---|---|---|---|---|---|---|---|
| | 50 Deg. | | | 49 Deg. | | | 48 Deg. | |

## *A Table of Northing and Southing.*

| Distance. | 43 Deg. N | S | EW | Distance. | 44 Deg. N | S | EW | Distance. | 45 Deg. N | S | EW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .7 | | .7 | 1 | .7 | | .7 | 1 | .7 | | .7 |
| 2 | 1.5 | | 1.4 | 2 | 1.4 | | 1.4 | 2 | 1.4 | | 1.4 |
| 3 | 2.2 | | 2.0 | 3 | 2.2 | | 2.1 | 3 | 2.1 | | 2.1 |
| 4 | 2.9 | | 2.7 | 4 | 2.9 | | 2.8 | 4 | 2.8 | | 2.8 |
| 5 | 3.6 | | 3.4 | 5 | 3.6 | | 3.5 | 5 | 3.5 | | 3.5 |
| 6 | 4.4 | | 4.1 | 6 | 4.3 | | 4.2 | 6 | 4.2 | | 4.2 |
| 7 | 5.1 | | 4.8 | 7 | 5.0 | | 4.9 | 7 | 4.9 | | 4.9 |
| 8 | 5.8 | | 5.4 | 8 | 5.8 | | 5.6 | 8 | 5.6 | | 5.6 |
| 9 | 6.6 | | 6.1 | 9 | 6.5 | | 6.2 | 9 | 6.4 | | 6.4 |
| 10 | 7.3 | | 6.8 | 10 | 7.2 | | 6.9 | 10 | 7.1 | | 7.1 |
| 20 | 14.6 | | 13.6 | 20 | 14.4 | | 13.9 | 20 | 14.1 | | 14.1 |
| 30 | 21.9 | | 20.5 | 30 | 21.6 | | 20.8 | 30 | 21.2 | | 21.2 |
| 40 | 29.2 | | 27.3 | 40 | 28.8 | | 27.8 | 40 | 28.3 | | 28.3 |
| 50 | 36.6 | | 34.1 | 50 | 36.0 | | 34.7 | 50 | 35.3 | | 35.3 |
| 60 | 43.9 | | 40.9 | 60 | 43.2 | | 41.7 | 60 | 42.4 | | 42.4 |
| 70 | 51.2 | | 47.7 | 70 | 50.3 | | 48.6 | 70 | 49.5 | | 49.5 |
| 80 | 58.5 | | 54.6 | 80 | 57.5 | | 55.6 | 80 | 56.6 | | 56.6 |
| 90 | 65.8 | | 61.4 | 90 | 64.7 | | 62.5 | 90 | 63.6 | | 63.6 |
| 100 | 73.1 | | 68.2 | 100 | 71.9 | | 69 5 | 100 | 70.7 | | 70.7 |
| Dist. | EW | N | S | Dist. | EW | N | S | Dist. | EW | N | S |
| | 47 Deg. | | | | 46 Deg. | | | | 45 Deg. | | |

# THE USE OF THE FOREGOING TABLE.

I HAVE already ſufficiently, in the ſixth chapter of this book, explained the uſe of this table; however becauſe it is made ſomewhat different from ſuch of this kind as have been made by others, I will briefly, by an example or two, explain it. Admit in ſurveying a wood, or the like, you run a line N. E. 40 degrees, 10 chains: or which is the ſame thing, a line 10 chains in length, that makes an angle with the meridian of 40 degrees to the eaſtward; and you would put down in your Field-Book the northing and eaſting of this line, under their proper titles N. and E. according to Mr. Norwood's way of ſurveying, taught in the ſixth chapter of this book.

Firſt, at the head of the table find 40 degrees, then in the column of diſtances ſeek for 10 chains, which being had, you will find to ſtand right againſt it, under the title N. 7. 7. for the north-

ing, which is 7 chains, $\frac{1}{10}$ of a chain: and for the eaſting, under the title E. 6. 4. which is ſix chains, $\frac{4}{10}$ of a chain, as nigh as may be expreſſed in tenths of a chain: but if you would know to one link, join a cypher to the diſtance, ſo will 10 be 100; which ſeek for in the ſame page of the table, and right againſt it you will find under title N. 76.6, or 7 chains, 66 links for your northing; and under title E. 64.3, or 6 chains, 43 links for your eaſting: which found, put down in your Field Book accordingly; and having done ſo by all your lines, if you find the northing and ſouthing the ſame, alſo the eaſting and weſting, you may be ſure you have wrought true, otherwiſe not.

If the diſtance conſiſts of odd chains and links, as moſt commonly happens, then take them ſeverally out of the table, and by adding all together you will have your deſire. As for example;

Suppoſe my diſtance run upon any line be N. W. 35 degrees, 15 chains, 20 links: N.

| | Ch. | Ch. | Lin. |
|---|---|---|---|
| Firſt in the table I find the northing of 10 chains to be - | 10 | 8 | 19 |
| | 5 | 4 | 10 |
| | 20 L. | 0 | $16\frac{4}{10}$ |
| | 45 | 12 | $16\frac{4}{10}$ |

Which added together, makes 12 chains, 45 links $\frac{4}{10}$ for the northing of that diſtance run. In like manner

manner under 35 degrees and title W. I find the westing of the same line, as here:

| Ch. | Ch. | Lin. |
|---|---|---|
| 10 | 5 | 74 |
| 5 | 2 | 87 |
| 20 Lin. | 0 | 11 $\frac{5}{10}$ |
| | 8 | 72 $\frac{5}{10}$ |

By which I conclude the northing of that line to be 12 chains, 45 links $\frac{4}{10}$, and the westing 8 chains, 72 links $\frac{5}{10}$: which thus you may prove by the logarithms.

| | |
|---|---|
| As radius - - - - - - - - | 10,000000 |
| is to the distance 15.20 - - | 3,181844 |
| So is the sine of the course 35 degrees | 9,758591 |
| To the westing 8 chains, 72 links | 2,940345 |
| And, as radius - - - - - - | 10,000000 |
| to the distance 15 chains, 20 links | 3,181844 |
| So co-sine of the course 55 - - | 9,913364 |
| to the northing 12 chains, 45 links | 3,095208 |

*Note*, If your course had been S. E. it would have been the same thing as N. W. for you see in the tables N. and S. E. and W. are joined to-

 gether,

gether. If your degrees exceed 45, then ſeek for them at the foot of the table: and over the titles N. S. E. W. find out the northing, ſouthing, eaſting, or weſting.

This I apprehend to be as much as need be ſaid concerning the preceding table: and as for finding the horizontal line of a hill, and ſuch other things by the table, you will find ſufficient directions in the chapter of trigonometry.

---

A TA-

A

# TABLE

OF

## SINES and TANGENTS

To every Fifth Minute of the

## QUADRANT.

0.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 0.000000 | 10.000000 | 0.000000 | Infinita. | 60 |
| 5 | 7.162696 | 9.999999 | 7.162696 | 12.837304 | 55 |
| 10 | 7.463726 | 9.999998 | 7.463727 | 12.536273 | 50 |
| 15 | 7.639816 | 9.999996 | 7.639820 | 12.360180 | 45 |
| 20 | 7.764754 | 9.999993 | 7.764761 | 12.235239 | 40 |
| 25 | 7.861662 | 9.999989 | 7.861674 | 12.138326 | 35 |
| 30 | 7.940842 | 9.999983 | 7.940858 | 12.059142 | 30 |
| 35 | 8.007787 | 9.999977 | 8.007809 | 11.992191 | 25 |
| 40 | 8.065776 | 9.999971 | 8.065806 | 11.934194 | 20 |
| 45 | 8.116926 | 9.999963 | 8.116963 | 11.883037 | 15 |
| 50 | 8.162681 | 9.999954 | 8.162737 | 11.837273 | 10 |
| 55 | 8.204070 | 9.999944 | 8.204126 | 11.795874 | 5 |
| 60 | 8.241855 | 9.999934 | 8.241921 | 11.758079 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

89.

1.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 8.241855 | 9.999934 | 8.241921 | 11.758079 | 60 |
| 5 | 8.276614 | 9.999922 | 8.276691 | 11.723309 | 55 |
| 10 | 8.308794 | 9.999910 | 8.308884 | 11.691116 | 50 |
| 15 | 8.338753 | 9.999897 | 8.338856 | 11.661144 | 45 |
| 20 | 8.366777 | 9.999882 | 8.366895 | 11.630105 | 40 |
| 25 | 8.393101 | 9.999867 | 8.393234 | 11.606766 | 35 |
| 30 | 8.417919 | 9.999851 | 8.418068 | 11.581932 | 30 |
| 35 | 8.441394 | 9.999834 | 8.441560 | 11.558440 | 25 |
| 40 | 8.463665 | 9.999816 | 8.463849 | 11.536151 | 20 |
| 45 | 8.484848 | 9.999797 | 8.485050 | 11.514950 | 15 |
| 50 | 8.505045 | 9.999778 | 8.505267 | 11.494733 | 10 |
| 55 | 8.524343 | 9.999757 | 8.524586 | 11.475414 | 5 |
| 60 | 8.542810 | 9.999735 | 8.542084 | 11.456916 | 0 |
| | C-osine. | Sine. | Co-tang. | Tangent. | M |

88.

2.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 8.542819 | 9.999735 | 8.543084 | 11.456916 | 60 |
| 5 | 8.560540 | 9.999713 | 8.560828 | 11.439172 | 55 |
| 10 | 8.577566 | 9.999689 | 8.577877 | 11.422123 | 50 |
| 15 | 8.593948 | 9.999665 | 8.594283 | 11.405717 | 45 |
| 20 | 8.609734 | 9.999640 | 8.610094 | 11.389906 | 40 |
| 25 | 8.624965 | 9.999614 | 8.625352 | 11.374648 | 35 |
| 30 | 8.639680 | 9.999586 | 8.640093 | 11.359907 | 30 |
| 35 | 8.653911 | 9.999558 | 8.654352 | 11.345648 | 25 |
| 40 | 8.667689 | 9.999529 | 8.668160 | 11.331840 | 20 |
| 45 | 8.681043 | 9.999500 | 8.681544 | 11.318456 | 15 |
| 50 | 8.693998 | 9.999469 | 8.694529 | 11.305471 | 10 |
| 55 | 8.706577 | 9.999437 | 8.707140 | 11.292860 | 5 |
| 60 | 8.718800 | 9.999404 | 8.719396 | 11.280604 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

87.

3.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 8.718800 | 9.999404 | 8.719396 | 11.280604 | 60 |
| 5 | 8.730688 | 9.999371 | 8.731317 | 11.268683 | 55 |
| 10 | 8.742250 | 9.999336 | 8.742922 | 11.257078 | 50 |
| 15 | 8.753528 | 9.999301 | 8.754227 | 11.245773 | 45 |
| 20 | 8.764511 | 9.999265 | 8.765246 | 11.234754 | 40 |
| 25 | 8.775223 | 9.999227 | 8.775995 | 11.224005 | 35 |
| 30 | 8.785675 | 9.999189 | 8.786486 | 11.213514 | 30 |
| 35 | 8.795881 | 9.999150 | 8.796731 | 11.203269 | 25 |
| 40 | 8.805852 | 9.999110 | 8.806742 | 11.193258 | 20 |
| 45 | 8.815599 | 9.999069 | 8.816529 | 11.183471 | 15 |
| 50 | 8.825130 | 9.999027 | 8.826103 | 11.173897 | 10 |
| 55 | 8.834456 | 9.998984 | 8.835471 | 11.164529 | 5 |
| 60 | 8.843585 | 9.998941 | 8.844644 | 11.155356 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

4.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 8.843585 | 9.998941 | 8.844644 | 11.155356 | 60 |
| 5 | 8.852525 | 9.998896 | 8.853628 | 11.146372 | 55 |
| 10 | 8.861283 | 9.998851 | 8.852433 | 11.13 567 | 50 |
| 15 | 8.869808 | 9.998804 | 8.871064 | 11.128936 | 45 |
| 20 | 8.878285 | 9.998757 | 8.879529 | 11.120471 | 40 |
| 25 | 8.886542 | 9.998708 | 8.887833 | 11.112167 | 35 |
| 30 | 8.894643 | 9.998659 | 8.895984 | 11.104016 | 30 |
| 35 | 8.902596 | 9.998609 | 8.903987 | 11.096013 | 25 |
| 40 | 8.910404 | 9.998558 | 8.911846 | 11.088154 | 20 |
| 45 | 8.918073 | 9.998506 | 8.919568 | 11.080432 | 15 |
| 50 | 8.925609 | 9.998453 | 8.927156 | 11.072844 | 10 |
| 55 | 8.933015 | 9.998399 | 8.934616 | 11.065384 | 5 |
| 60 | 8.940296 | 9.998344 | 8.941952 | 11.058048 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

85.

5.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 8.940296 | 9.998344 | 8.941952 | 11.058048 | 60 |
| 5 | 8.947456 | 9.998289 | 8.949168 | 11.050832 | 55 |
| 10 | 8.954499 | 9.998232 | 8.956267 | 11.043733 | 50 |
| 15 | 8.961429 | 9.998174 | 8.963255 | 11.036745 | 45 |
| 20 | 8.968249 | 9.998116 | 8.970133 | 11.029867 | 40 |
| 25 | 8.974962 | 9.998056 | 8.976906 | 11.023094 | 35 |
| 30 | 8.981573 | 9.997996 | 8.983577 | 11.016423 | 30 |
| 35 | 8.988083 | 9.997935 | 8.990149 | 11.009851 | 25 |
| 40 | 8.994497 | 9.997872 | 8.996624 | 11.003376 | 20 |
| 45 | 9.000816 | 9.997809 | 9.003007 | 10.996993 | 15 |
| 50 | 9.007044 | 9.997745 | 9.009298 | 10.990702 | 10 |
| 55 | 9.013182 | 9.997680 | 9.015502 | 10.984498 | 5 |
| 60 | 9.019235 | 9.997614 | 9.021620 | 10.978380 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

84.

6.

| M | Sine. | Co-fine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.019235 | 9.997614 | 9.021620 | 10.978380 | 60 |
| 5 | 9.025203 | 9.997547 | 9.027655 | 10.972345 | 55 |
| 10 | 9.031089 | 9.997480 | 9.033609 | 10.966391 | 50 |
| 15 | 9.036896 | 9.997411 | 9.039485 | 10.960515 | 45 |
| 20 | 9.042625 | 9.997341 | 9.045284 | 10.954710 | 40 |
| 25 | 9.048279 | 9.997271 | 9.051008 | 10.948992 | 35 |
| 30 | 9.053859 | 9.997199 | 9.056659 | 10.943341 | 30 |
| 35 | 9.059367 | 9.997127 | 9.062240 | 10.937760 | 25 |
| 40 | 9.064806 | 9.997053 | 9.067752 | 10.932248 | 20 |
| 45 | 9.070176 | 9.996979 | 9.073197 | 10.926803 | 15 |
| 50 | 9.075480 | 9.996904 | 9.078576 | 10.921424 | 10 |
| 55 | 9.080719 | 9.996828 | 9.083891 | 10.916109 | 5 |
| 60 | 9.085894 | 9.996751 | 9.089144 | 10.910856 | 0 |
| | Co-fine. | Sine. | Co-tang | Tangent. | M |

83.

7.

| M | Sine. | Co-fine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.085894 | 9.996751 | 9.089144 | 10.910850 | 60 |
| 5 | 9.091008 | 9.996673 | 9.094336 | 10.905664 | 55 |
| 10 | 9.096062 | 9.996594 | 9.099468 | 10.900532 | 50 |
| 15 | 9.101056 | 9.996514 | 9.104542 | 10.895458 | 45 |
| 20 | 9.105992 | 9.996433 | 9.109559 | 10.890441 | 40 |
| 25 | 9.110873 | 9.996351 | 9.114521 | 10.885479 | 35 |
| 30 | 9.115698 | 9.996269 | 9.119429 | 10.880571 | 30 |
| 35 | 9.120469 | 9.996185 | 9.124284 | 10.875716 | 25 |
| 40 | 9.125187 | 9.996100 | 9.129087 | 10.870913 | 20 |
| 45 | 9.129854 | 9.996015 | 9.133839 | 10.866161 | 15 |
| 50 | 9.134470 | 9.995928 | 9.138542 | 10.861458 | 10 |
| 55 | 9.139037 | 9.995841 | 9.143196 | 10.856804 | 5 |
| 60 | 9.143554 | 9.995753 | 9.147803 | 10.852197 | 0 |
| | Co-fine. | Sine. | Co-tang. | Tangent. | M |

82.

## *The Table of Sines and Tangents.*

8.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.143555 | 9.995753 | 9.147803 | 10.852197 | 60 |
| 5 | 9.148026 | 9.995604 | 9.152363 | 10.847637 | 55 |
| 10 | 9.152451 | 9.995573 | 9.156877 | 10.843123 | 50 |
| 15 | 9.156830 | 9.995482 | 9.161347 | 10.838653 | 45 |
| 20 | 9.161164 | 9.995390 | 9.165774 | 10.834226 | 40 |
| 25 | 9.165454 | 9.995297 | 9.170157 | 10.829843 | 35 |
| 30 | 9.169702 | 9.995203 | 9.174499 | 10.825501 | 30 |
| 35 | 9.173908 | 9.995108 | 9.178799 | 10.821201 | 25 |
| 40 | 9.178072 | 9.995013 | 9.183059 | 10.816941 | 20 |
| 45 | 9.182196 | 9.994916 | 9.187280 | 10.812720 | 15 |
| 50 | 9.186280 | 9.994818 | 9.191462 | 10.808538 | 10 |
| 55 | 9.190325 | 9.994720 | 9.195606 | 10.804394 | 5 |
| 60 | 9.194332 | 9.994620 | 9.199713 | 10.800287 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

81.

9.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.194332 | 9.994620 | 9.199713 | 10.800287 | 60 |
| 5 | 9.198102 | 9.994159 | 9.203782 | 10.796218 | 55 |
| 10 | 9.202234 | 9.994418 | 9.207817 | 10.792183 | 50 |
| 15 | 9.206131 | 9.994316 | 9.211815 | 10.788185 | 45 |
| 20 | 9.209992 | 9 994212 | 9.215780 | 10.784220 | 40 |
| 25 | 9.213818 | 9.994108 | 9.219710 | 10.780290 | 35 |
| 30 | 9.217609 | 9.994003 | 9.223607 | 10.776393 | 30 |
| 35 | 9.221367 | 9.993897 | 9.227471 | 10.772529 | 25 |
| 40 | 9.225092 | 9.993789 | 9.231302 | 10.768698 | 20 |
| 45 | 9.228784 | 9.993681 | 9.235103 | 10.764897 | 15 |
| 50 | 9.232444 | 9.993572 | 9.238872 | 10.761128 | 10 |
| 55 | 9.236083 | 9.993462 | 9.242610 | 10.757390 | 5 |
| 60 | 9.239670 | 9.993351 | 9.246319 | 10.753681 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

80.

10.

| M | Sine. | Co-fine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.239670 | 9.993351 | 9.246319 | 10 753081 | 60 |
| 5 | 9.243237 | 9.993240 | 9.249998 | 10.750002 | 55 |
| 10 | 9 246775 | 9.993127 | 9.253648 | 10.746352 | 50 |
| 15 | 9.250282 | 9.993013 | 9.257269 | 10.742731 | 45 |
| 20 | 9.253761 | 9.992898 | 9.260863 | 10.739137 | 40 |
| 25 | 9.257211 | 9.992783 | 9.264428 | 10.735572 | 35 |
| 30 | 9.260633 | 9.992666 | 9.267967 | 10.732033 | 30 |
| 35 | 9.264027 | 9.992549 | 9.271479 | 10.728521 | 25 |
| 40 | 9.267395 | 9.992430 | 9.274964 | 10.725036 | 20 |
| 45 | 9.270735 | 9.992311 | 9.278424 | 10.721576 | 15 |
| 50 | 9.274049 | 9.992190 | 9.281858 | 10.718142 | 10 |
| 55 | 9.277337 | 9.992069 | 9.285268 | 10.714732 | 5 |
| 60 | 9.280599 | 9.991947 | 9.288652 | 10.711348 | 0 |
| | Co-fine. | Sine. | Co-tang. | Tangent. | M |

79.

11.

| M | Sine. | Co-fine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9 280599 | 9.991974 | 0.288652 | 10 711348 | 60 |
| 5 | 9 283836 | 9.991823 | 9.292013 | 10.707987 | 55 |
| 10 | 9.287048 | 9.991699 | 9.295949 | 10.704651 | 50 |
| 15 | 9.260236 | 9.991574 | 9.298662 | 10.701338 | 45 |
| 20 | 9.293399 | 9.991448 | 9.301951 | 10.698049 | 40 |
| 25 | 9.296539 | 9.991321 | 9.305218 | 10.694782 | 35 |
| 30 | 9.299655 | 9.991193 | 9.308463 | 10 691537 | 30 |
| 35 | 9.302748 | 9.991064 | 9.311685 | 10.688315 | 25 |
| 40 | 9.305819 | 9.990934 | 9 314885 | 10.685115 | 20 |
| 45 | 9.308867 | 9.990803 | 9.3180 4 | 10 681936 | 15 |
| 50 | 9.311893 | 9.990671 | 9.321222 | 10 678778 | 10 |
| 55 | 9.314897 | 9.990538 | 9.324358 | 10.675642 | 5 |
| 60 | 9.317879 | 9.990404 | 9.327475 | 10 672525 | 0 |
| | Co-fine. | Sine. | Co tang | Tangent. | M |

12.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.317879 | 9.990404 | 9.327475 | 10.672525 | 60 |
| 5 | 9.320840 | 9.990270 | 9.330570 | 10.669430 | 55 |
| 10 | 9.323780 | 9.990134 | 9.333646 | 10.666354 | 50 |
| 15 | 9.326700 | 9.989997 | 9.336702 | 10.663298 | 45 |
| 20 | 9.329599 | 9.989860 | 9.339739 | 10.660261 | 40 |
| 25 | 9.332478 | 9.989721 | 9.342757 | 10.657243 | 35 |
| 30 | 9.335337 | 9.989582 | 9.345755 | 10.654245 | 30 |
| 35 | 9.338176 | 9.989441 | 9.348735 | 10.651265 | 25 |
| 40 | 9.340996 | 9.989300 | 9.351697 | 10.648303 | 20 |
| 45 | 9.343797 | 9.989157 | 9.354640 | 10.645360 | 15 |
| 50 | 9.346579 | 9.989014 | 9.357566 | 10.642434 | 10 |
| 55 | 9.349343 | 9.988869 | 9.360474 | 10.639526 | 5 |
| 60 | 9.352088 | 9.988724 | 9.363364 | 10.636636 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

77.

13.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.352088 | 9.988724 | 9.363364 | 10.636636 | 60 |
| 5 | 9.354815 | 9.988578 | 9.366237 | 10.633763 | 55 |
| 10 | 9.357524 | 9.988430 | 9.369094 | 10.630906 | 50 |
| 15 | 9.360215 | 9.988282 | 9.371933 | 10.628067 | 45 |
| 20 | 9.362889 | 9.988133 | 9.374756 | 10.625244 | 40 |
| 25 | 9.365546 | 9.987983 | 9.377563 | 10.622437 | 35 |
| 30 | 9.368185 | 9.987832 | 9.380354 | 10.619646 | 30 |
| 35 | 9.370808 | 9.987679 | 9.383129 | 10.616871 | 25 |
| 40 | 9.373414 | 9.987526 | 9.385888 | 10.614112 | 20 |
| 45 | 9.376003 | 9.987372 | 9.388631 | 10.611369 | 15 |
| 50 | 9.378577 | 9.987217 | 9.391360 | 10.608640 | 10 |
| 55 | 9.381134 | 9.987061 | 9.394073 | 10.605927 | 5 |
| 60 | 9.383675 | 9.987904 | 9.396771 | 10.603229 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

76.

14.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.383675 | 9.986904 | 9.390771 | 10.603229 | 60 |
| 5 | 9.386201 | 9.986746 | 9.399455 | 10.600545 | 55 |
| 10 | 9.388711 | 9.986587 | 9.402124 | 10.597876 | 50 |
| 15 | 9.381206 | 9.986427 | 9.404778 | 10.595222 | 45 |
| 20 | 9.393685 | 9.986266 | 9.407419 | 10.592581 | 40 |
| 25 | 9.396150 | 9.986104 | 9.410045 | 10.589955 | 35 |
| 30 | 9.398600 | 9.985942 | 9.412658 | 10.587342 | 30 |
| 35 | 9.401035 | 9.985778 | 9.415257 | 10.584743 | 25 |
| 40 | 9.403455 | 9.985613 | 9.417842 | 10.582158 | 20 |
| 45 | 9.405862 | 9.985447 | 9.420415 | 10.579585 | 15 |
| 50 | 9.408254 | 9.985280 | 9.422974 | 10.577026 | 10 |
| 55 | 9.410632 | 9 985113 | 9.425519 | 10.574481 | 5 |
| 60 | 9.412996 | 9.984944 | 9 428052 | 10.571948 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

75.

15.

| M | Sine. | Co-ſine. | Tangent | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.412996 | 9.984944 | 9.428052 | 10.571948 | 60 |
| 5 | 9.415347 | 9.984774 | 9.430573 | 10.569427 | 55 |
| 10 | 9.417684 | 9.984603 | 9.433080 | 10.566920 | 50 |
| 15 | 9.420007 | 9.984432 | 9.435576 | 10.564424 | 45 |
| 20 | 9.422318 | 9.984259 | 9.438059 | 10.561941 | 40 |
| 25 | 9.424615 | 9.984085 | 9.440529 | 10.559471 | 35 |
| 30 | 9.426899 | 9.983911 | 9.442988 | 10.557012 | 30 |
| 35 | 9.429170 | 9.983735 | 9.445435 | 10.554565 | 25 |
| 40 | 9.431429 | 9.983558 | 9.447870 | 10.552130 | 20 |
| 45 | 9.433675 | 9.983381 | 9.450294 | 10.549706 | 15 |
| 50 | 9.435908 | 9.983202 | 9.458706 | 10.547294 | 10 |
| 55 | 9.438129 | 9.983022 | 9.455107 | 10.544893 | 5 |
| 60 | 9.440338 | 9.982842 | 9.457496 | 10.542504 | 0 |
| | Co ſine. | Sine. | Co-tang. | Tangent. | M |

16.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.440338 | 9.982842 | 9.457496 | 10.542504 | 60 |
| 5 | 9.442535 | 9.982660 | 9.459875 | 10.540125 | 55 |
| 10 | 9.444720 | 9.982477 | 9.462242 | 10.537758 | 50 |
| 15 | 9.446893 | 9.982294 | 9.464599 | 10.535401 | 45 |
| 20 | 9.449054 | 9.982169 | 9.466945 | 10.533055 | 40 |
| 25 | 9.451204 | 9.981924 | 9.469280 | 10.530720 | 35 |
| 30 | 9.453342 | 9.981737 | 9.471605 | 10.528395 | 30 |
| 35 | 9.455469 | 9.981549 | 9.473919 | 10.526081 | 25 |
| 40 | 9.457584 | 9.981361 | 9.476223 | 10.523777 | 20 |
| 45 | 9.459688 | 9.981171 | 9.478517 | 10.521483 | 15 |
| 50 | 9.461782 | 9.980981 | 9.480801 | 10.519199 | 10 |
| 55 | 9.463864 | 9.980789 | 9.483075 | 10.516925 | 5 |
| 60 | 9.465935 | 9.980596 | 9.485339 | 10.514661 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

73.

17.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.465935 | 9.980596 | 9.485339 | 10.514661 | 60 |
| 5 | 9.467996 | 9.980403 | 9.487593 | 10.512407 | 55 |
| 10 | 9.470046 | 9.980208 | 9.489838 | 10.510162 | 50 |
| 15 | 9.472086 | 9.980012 | 9.492073 | 10.507927 | 45 |
| 20 | 9.474115 | 9.979816 | 9.494299 | 10.505701 | 40 |
| 25 | 9.476133 | 9.979618 | 9.496515 | 10.503485 | 35 |
| 30 | 9.478142 | 9.979420 | 9.498722 | 10.501278 | 30 |
| 35 | 9.480140 | 9.979220 | 9.500920 | 10.499080 | 25 |
| 40 | 9.482128 | 9.979019 | 9.503109 | 10.496891 | 20 |
| 45 | 9.484107 | 9.978817 | 9.505289 | 10.494711 | 15 |
| 50 | 9.486075 | 9.978615 | 9.507460 | 10.492540 | 10 |
| 55 | 9.488034 | 9.978411 | 9.509622 | 10.490378 | 5 |
| 60 | 9.489982 | 9.978206 | 9.511776 | 10.488224 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

72.

18.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.489982 | 9.978206 | 9.511776 | 10.488222 | 60 |
| 5 | 9.491922 | 9.978001 | 9.513921 | 10.486076 | 55 |
| 10 | 9.493851 | 9.977794 | 9.516057 | 10.483943 | 50 |
| 15 | 9.495772 | 9.977586 | 9.518186 | 10.481814 | 45 |
| 20 | 9.497682 | 9.977377 | 9.520305 | 10.479695 | 40 |
| 25 | 9.499584 | 9.977167 | 9.522417 | 10.477583 | 35 |
| 30 | 9.401476 | 9.976957 | 9.524520 | 10.475480 | 30 |
| 35 | 9.503360 | 9.976745 | 2.526615 | 10.473385 | 25 |
| 40 | 9.505234 | 9.976532 | 9.528702 | 10.471298 | 20 |
| 45 | 9.507099 | 9.976318 | 2.530781 | 10.469219 | 15 |
| 50 | 9.508956 | 9.976103 | 9.532853 | 10.467147 | 10 |
| 55 | 9.510803 | 9.975887 | 9.534916 | 10.465084 | 5 |
| 60 | 9.512642 | 9.975670 | 9.536972 | 10.463028 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

71.

19.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.512642 | 9.975670 | 9.536972 | 10.460028 | 60 |
| 5 | 9.514472 | 9.975452 | 9.539020 | 10.460980 | 55 |
| 10 | 9.516294 | 9.975233 | 9.541061 | 10.458939 | 50 |
| 15 | 9.518107 | 9.975013 | 9.543094 | 10.456906 | 45 |
| 20 | 9.519911 | 9.974792 | 9.545119 | 10.454881 | 40 |
| 25 | 9.521707 | 9.974570 | 9.547138 | 10.452862 | 35 |
| 30 | 9.523495 | 9.974347 | 9.549149 | 10.450851 | 30 |
| 35 | 9.525275 | 9.974122 | 9.551153 | 10.448847 | 25 |
| 40 | 9.527046 | 9.973897 | 9.553149 | 10.446851 | 20 |
| 45 | 9.528810 | 9.97397I | 9.555139 | 10.444861 | 15 |
| 50 | 9.530565 | 9.973444 | 9.557121 | 10.442879 | 10 |
| 55 | 9.532312 | 9.973215 | 9.559097 | 10.440903 | 5 |
| 60 | 9.534052 | 9.972986 | 9.551066 | 10.438934 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

70.

20.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.534052 | 9.972966 | 9.561066 | 10.438934 | 60 |
| 5 | 9.535783 | 9.972755 | 9.563028 | 10.436972 | 55 |
| 10 | 9.537507 | 9.972524 | 9.564983 | 10.435017 | 50 |
| 15 | 9.539223 | 9.972291 | 9.566932 | 10.433068 | 45 |
| 20 | 9.540931 | 9.972058 | 9.568873 | 10.431127 | 40 |
| 25 | 9.542632 | 9.971823 | 9.570809 | 10.429191 | 35 |
| 30 | 9.544325 | 9.971583 | 9.572738 | 10.427262 | 30 |
| 35 | 9.546011 | 9.971351 | 9.574660 | 10.425340 | 25 |
| 40 | 9.547689 | 9.971113 | 9.576576 | 10.423424 | 20 |
| 45 | 9.549360 | 9.970874 | 9.578486 | 10.421514 | 15 |
| 50 | 9.551024 | 9.970635 | 9.580389 | 10.419611 | 10 |
| 55 | 9.552680 | 9.970394 | 9.582286 | 10.417714 | 5 |
| 60 | 9.554329 | 9.970152 | 9.584177 | 10.415823 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

69.

21.

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.554329 | 9.970152 | 9.584177 | 10.415823 | 60 |
| 5 | 9.555971 | 9.969909 | 9.586062 | 10.413938 | 55 |
| 10 | 9.557606 | 9.969665 | 9.587941 | 10.412059 | 50 |
| 15 | 9.559234 | 9.969420 | 9.589814 | 10.410186 | 45 |
| 20 | 9.560855 | 9.969173 | 9.591681 | 10.408319 | 40 |
| 25 | 9.562468 | 9.968926 | 9.593542 | 10.406458 | 35 |
| 30 | 9.564075 | 9.968678 | 9.595398 | 10.404602 | 30 |
| 35 | 9.565676 | 9.968429 | 9.597247 | 10.402753 | 25 |
| 40 | 9.567269 | 9.968178 | 9.599091 | 10.400909 | 20 |
| 45 | 9.568856 | 9.967927 | 9.600929 | 10.399071 | 15 |
| 50 | 9.570435 | 9.967674 | 9.602761 | 10.397239 | 10 |
| 55 | 9.572009 | 9.967421 | 9.604588 | 10.395412 | 5 |
| 60 | 9.573575 | 9.967166 | 9.606410 | 10.393590 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

68.

22.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.573575 | 9.967166 | 9.606410 | 10.393590 | 60 |
| 5 | 9.575136 | 9.966910 | 9.608225 | 10.391775 | 55 |
| 10 | 9.576689 | 9.966653 | 9.610036 | 10.389964 | 50 |
| 15 | 9.578236 | 9.966395 | 9.611841 | 10.388159 | 45 |
| 20 | 9.579777 | 9.966136 | 9.613641 | 10.386359 | 40 |
| 25 | 9.581312 | 9.965876 | 9.615435 | 10.384565 | 35 |
| 30 | 9.582840 | 9.965615 | 9.617224 | 10.382776 | 30 |
| 35 | 9.584361 | 9.965353 | 9.619008 | 10.380992 | 25 |
| 40 | 9.585877 | 9.965090 | 9.620787 | 10.379213 | 20 |
| 45 | 9.587386 | 9.964826 | 9.622561 | 10.377439 | 15 |
| 50 | 9.588890 | 9.964560 | 9.624330 | 10.375670 | 10 |
| 55 | 9.590387 | 9.964294 | 9.626093 | 10.373907 | 5 |
| 60 | 9.591878 | 9.964026 | 9.627852 | 10.372148 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

67.

23.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.591878 | 9.964026 | 9.627852 | 10.372148 | 60 |
| 5 | 9.593363 | 9.963757 | 9.629606 | 10.370394 | 55 |
| 10 | 9.594842 | 9.963488 | 9.631355 | 10.368645 | 50 |
| 15 | 9.596315 | 9.963217 | 9.633098 | 10.366902 | 45 |
| 20 | 9.597783 | 9.962945 | 9.634838 | 10.365162 | 40 |
| 25 | 9.599244 | 9.962672 | 9.636572 | 10.363428 | 35 |
| 30 | 9.600700 | 9.962398 | 9.638302 | 10.361698 | 30 |
| 35 | 9.602150 | 9.962123 | 9.640027 | 10.359973 | 25 |
| 40 | 9.603594 | 9.961846 | 9.641747 | 10.358253 | 20 |
| 45 | 9.605032 | 9.961569 | 9.643463 | 10.356537 | 15 |
| 50 | 9.606465 | 9.961290 | 9.645174 | 10.354826 | 10 |
| 55 | 9.607892 | 9.961011 | 9.646881 | 10.353119 | 5 |
| 60 | 9.609313 | 9.960730 | 9.648583 | 10.351417 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

66.

24.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.609313 | 9.960730 | 9.648583 | 10.351417 | 60 |
| 5 | 9.610729 | 9.960448 | 9.650281 | 10.349719 | 55 |
| 10 | 9.612140 | 9.960165 | 9.651974 | 10.348026 | 50 |
| 15 | 9.613545 | 9.959882 | 9.653663 | 10.346337 | 45 |
| 20 | 9.614944 | 9.959596 | 9.655348 | 10.344652 | 40 |
| 25 | 9.616338 | 9.959310 | 9.657028 | 10.342972 | 35 |
| 30 | 9.617727 | 9.959023 | 9.658704 | 10.341296 | 30 |
| 35 | 9.619110 | 9.958734 | 9.660376 | 10.339624 | 25 |
| 40 | 9.620488 | 9.958445 | 9.662043 | 10.337957 | 20 |
| 45 | 9.621861 | 9.958154 | 9.663707 | 10.336293 | 15 |
| 50 | 9.623229 | 9.957863 | 9.665366 | 10.334634 | 10 |
| 55 | 9.624591 | 9.957579 | 9.667021 | 10.332979 | 5 |
| 60 | 9.625948 | 9.957276 | 9.668673 | 10.331327 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

65.

25.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.625948 | 9.957276 | 9.668673 | 10.331327 | 60 |
| 5 | 9.627300 | 9.956981 | 9.670320 | 10.329680 | 55 |
| 10 | 9.628647 | 9.956684 | 9.671963 | 10.328037 | 50 |
| 15 | 9.629989 | 9.956387 | 9.673602 | 10.326398 | 45 |
| 20 | 9.631326 | 9.956089 | 9.675237 | 10.324763 | 40 |
| 25 | 9.632658 | 9.955789 | 9.676869 | 10.323131 | 35 |
| 30 | 9.633984 | 9.955488 | 9.678496 | 10.322504 | 30 |
| 35 | 9.635306 | 9.955186 | 9.680120 | 10.319880 | 25 |
| 40 | 9.636623 | 9.954883 | 9.681740 | 10.318260 | 20 |
| 45 | 9.637935 | 9.954579 | 9.683356 | 10.316644 | 15 |
| 50 | 9.639242 | 9.954274 | 9.684968 | 10.315032 | 10 |
| 55 | 9.640544 | 9.953968 | 9.686577 | 10.313423 | 5 |
| 60 | 9.641842 | 9.953660 | 9.688182 | 10.311818 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

64.

26.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.641842 | 9.953660 | 9.688182 | 10.311818 | 60 |
| 5 | 9.643135 | 9.953352 | 9.689783 | 10.310217 | 55 |
| 10 | 9.644423 | 9.953042 | 9.691381 | 10.308619 | 50 |
| 15 | 9.645706 | 9.952731 | 9.692975 | 10.307025 | 45 |
| 20 | 9.646984 | 9.952419 | 9.694566 | 10.305434 | 40 |
| 25 | 9.648258 | 9.952106 | 9.696153 | 10.303847 | 35 |
| 30 | 9.649527 | 9.951791 | 9.697736 | 10.302264 | 30 |
| 35 | 9.650792 | 9.951476 | 9.699316 | 10.300684 | 25 |
| 40 | 9.652052 | 9.951159 | 9.700893 | 10.299107 | 20 |
| 45 | 9.653308 | 9.950841 | 9.702466 | 10.297534 | 15 |
| 50 | 9.654558 | 9.950522 | 9.704036 | 10.295964 | 10 |
| 55 | 9.655805 | 9.950202 | 9.705603 | 10.294397 | 5 |
| 60 | 9.657047 | 9.959881 | 9.707166 | 10.292834 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

63.

27.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.657047 | 9.949881 | 9.707166 | 10.292834 | 60 |
| 5 | 9.658284 | 9.949558 | 9.708726 | 10.291274 | 55 |
| 10 | 9.659517 | 9.949235 | 9.710282 | 10.289718 | 50 |
| 15 | 9.660746 | 9 948910 | 9.711836 | 10.288104 | 45 |
| 20 | 9.661970 | 9.948584 | 9.713386 | 10.286614 | 40 |
| 25 | 9.663190 | 9.948257 | 9.714933 | 10.285067 | 35 |
| 30 | 9.664406 | 9.947929 | 9.716477 | 10.283523 | 30 |
| 35 | 9.665617 | 9.947600 | 9.718017 | 10.281983 | 25 |
| 40 | 9.666824 | 9.947269 | 9.719555 | 10.280445 | 20 |
| 45 | 9.668027 | 9.946937 | 9.721089 | 10.278911 | 15 |
| 50 | 9.669225 | 9.946604 | 9.722621 | 10.277379 | 10 |
| 55 | 9.670419 | 9 946270 | 9.724149 | 10.275851 | 5 |
| 60 | 9.671609 | 9.945935 | 9.725674 | 10.274326 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

62.

28.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.671609 | 9.945935 | 9.725674 | 10.274326 | 60 |
| 5 | 9.672795 | 9.945598 | 9.727197 | 10.272803 | 55 |
| 10 | 9.673977 | 9.945261 | 9.728716 | 10.271284 | 50 |
| 15 | 9.675155 | 9.944922 | 9.730233 | 10.269767 | 45 |
| 20 | 9.676328 | 9.944582 | 9.731746 | 10.268254 | 40 |
| 25 | 9.677498 | 9.944241 | 9.733257 | 10.266743 | 35 |
| 30 | 9.678663 | 9.943899 | 9.734764 | 10.265236 | 30 |
| 35 | 9.679824 | 9.943555 | 9.736269 | 10.263731 | 25 |
| 40 | 9.680982 | 9.943210 | 9.737771 | 10.262229 | 20 |
| 45 | 9.682135 | 9.942864 | 9.739271 | 10.260729 | 15 |
| 50 | 9.683284 | 9.942517 | 9.740767 | 10.259233 | 10 |
| 55 | 9.684430 | 9.942169 | 9.742261 | 10.257739 | 5 |
| 60 | 9.685571 | 9.941819 | 9.743752 | 10.256248 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

61.

29.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.685571 | 9.941819 | 9.743751 | 10.256248 | 60 |
| 5 | 9.686709 | 9.941469 | 9.745240 | 10.254760 | 55 |
| 10 | 9.687843 | 9.941117 | 9.746726 | 10.253274 | 50 |
| 15 | 9.688972 | 9.940763 | 9.748209 | 10.251791 | 45 |
| 20 | 9.690098 | 9.940409 | 9.749689 | 10.250311 | 40 |
| 25 | 9.691220 | 9.940054 | 9.751167 | 10.248833 | 35 |
| 30 | 9.692339 | 9.939697 | 9.752642 | 10.247358 | 30 |
| 35 | 9.693453 | 9.939339 | 9.754114 | 10.245885 | 25 |
| 40 | 9.694564 | 9.938980 | 9.755585 | 10.244415 | 20 |
| 45 | 9.695671 | 9.938619 | 9.757052 | 10.242948 | 15 |
| 50 | 9.696775 | 9.938258 | 9.758517 | 10.241483 | 10 |
| 55 | 9.697874 | 9.937895 | 9.759979 | 10.240021 | 5 |
| 60 | 9.698970 | 9.937531 | 9.761439 | 10.238561 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

60.

30.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.698970 | 9.937531 | 9.761439 | 10.238561 | 60 |
| 5 | 9.700062 | 9.937165 | 9.762897 | 10.237103 | 55 |
| 10 | 9.701151 | 9.936799 | 9.764352 | 10.235648 | 50 |
| 15 | 9.702236 | 9.936431 | 9.765805 | 10.234195 | 45 |
| 20 | 9.703317 | 9.936062 | 9.767255 | 10.232745 | 40 |
| 25 | 9.704395 | 9.935692 | 9.768703 | 10.231297 | 35 |
| 30 | 9.705469 | 9.935320 | 9.770148 | 10.229852 | 30 |
| 35 | 9.706539 | 9.934948 | 9.771592 | 10.228408 | 25 |
| 40 | 9.707606 | 9.934574 | 9.773033 | 10.226967 | 20 |
| 45 | 9.708670 | 9.934199 | 9.774471 | 10.825529 | 15 |
| 50 | 9.709730 | 9.933822 | 9.775908 | 10.224092 | 10 |
| 55 | 9.710786 | 9.933445 | 9.777342 | 10.222658 | 5 |
| 60 | 9.711839 | 9.933066 | 9.778774 | 10.221226 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

59.

31.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.711839 | 9.933066 | 9.778774 | 10.221226 | 60 |
| 5 | 9.712889 | 9.932685 | 9.780203 | 10.219797 | 55 |
| 10 | 9.713935 | 9.932304 | 9.781631 | 10.218369 | 50 |
| 15 | 9.714978 | 9.931921 | 9.783056 | 10.216944 | 45 |
| 20 | 9.716017 | 9.931537 | 9.784479 | 10.215521 | 40 |
| 25 | 9.717053 | 9.931152 | 9.785900 | 10.214100 | 35 |
| 30 | 9.718085 | 9.930766 | 9.787319 | 10.212681 | 30 |
| 35 | 9.719114 | 9.930378 | 9.788736 | 10.211264 | 25 |
| 40 | 9.720140 | 9.929989 | 9.790151 | 10.209849 | 20 |
| 45 | 9.721162 | 9.929599 | 9.791563 | 10.208437 | 15 |
| 50 | 9.722181 | 9.929207 | 9.792974 | 10.207026 | 10 |
| 55 | 9.723197 | 9.928815 | 9.794383 | 10.205617 | 5 |
| 60 | 9.724210 | 9.928420 | 9.795789 | 10.204211 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

32.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.724210 | 9.928420 | 9.795789 | 10.204211 | 60 |
| 5 | 9.725219 | 9.628025 | 9.797194 | 10.202806 | 55 |
| 10 | 9.726225 | 9.927629 | 9.798596 | 10.201404 | 50 |
| 15 | 9.727228 | 9.927231 | 9.799997 | 10.200003 | 45 |
| 20 | 9.728227 | 9.926831 | 9.801396 | 10.198604 | 40 |
| 25 | 9.729223 | 9.926431 | 9.802792 | 10.197208 | 35 |
| 30 | 9.720217 | 9.926029 | 9.804187 | 10.195813 | 30 |
| 35 | 9.731206 | 9.925626 | 9.805580 | 10.194420 | 25 |
| 40 | 9.732193 | 9.925222 | 9.806971 | 10.193029 | 20 |
| 45 | 9.733177 | 9.924816 | 9.808361 | 10.191639 | 15 |
| 50 | 9.734157 | 9.924409 | 9.809748 | 10.190252 | 10 |
| 55 | 9.735135 | 9.924001 | 9.811134 | 10.188866 | 5 |
| 60 | 9.736109 | 9.923591 | 9.812517 | 10.187483 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

57.

33.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.736109 | 9.923591 | 9.812571 | 10.187483 | 60 |
| 5 | 9.737080 | 9.923181 | 9.813899 | 10.186101 | 55 |
| 10 | 9.738048 | 9.922769 | 9.815280 | 10.184720 | 50 |
| 15 | 9.739013 | 9.92235- | 9.816658 | 10.183342 | 45 |
| 20 | 9.739975 | 9.921940 | 9.818035 | 10.181965 | 40 |
| 25 | 9.740934 | 9.921524 | 9.819410 | 10.180590 | 35 |
| 30 | 9.741889 | 9.921107 | 9.820783 | 10.179217 | 30 |
| 35 | 9.742842 | 9.920688 | 9.822154 | 10.177846 | 25 |
| 40 | 9.743792 | 9.920268 | 9.823524 | 10.176476 | 20 |
| 45 | 9.744739 | 9.919846 | 9.824893 | 10.175107 | 15 |
| 50 | 9.745683 | 9.919424 | 9.826259 | 10.173741 | 10 |
| 55 | 9.746624 | 9.919000 | 9.827624 | 10.172376 | 5 |
| 60 | 9.747562 | 9.918574 | 9.828987 | 10.171013 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

56.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.747562 | 9.918574 | 9.828987 | 10.171013 | 60 |
| 5 | 9.748497 | 9.918147 | 9.830349 | 10.169651 | 55 |
| 10 | 9.749429 | 9.917719 | 9.831709 | 10.168291 | 50 |
| 15 | 9.750358 | 9.917290 | 9.833068 | 10.166932 | 45 |
| 20 | 9.751284 | 9.916859 | 9.834425 | 10.165575 | 40 |
| 25 | 9.752208 | 9.916427 | 9.835780 | 10.164220 | 35 |
| 30 | 9.753128 | 9.915994 | 9.837134 | 10.162866 | 30 |
| 35 | 9.754046 | 9.915559 | 9.838487 | 10.161513 | 25 |
| 40 | 9.754960 | 9.915123 | 9.839838 | 10.160162 | 20 |
| 45 | 9.755872 | 9.914685 | 9.841187 | 10.158813 | 15 |
| 50 | 9.756782 | 9.914246 | 9.842535 | 10.157465 | 10 |
| 55 | 9.757688 | 9.913806 | 9.843882 | 10.156118 | 5 |
| 60 | 9.758591 | 9.913365 | 9.845227 | 10.154773 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |



| M | Sine. | Co-sine. | Tangent. | Co-tang. | M |
|---|---|---|---|---|---|
| 0 | 9.758591 | 9.913365 | 9.845227 | 10.154773 | 60 |
| 5 | 9.759492 | 9.912922 | 9.846570 | 10.153430 | 55 |
| 10 | 9.760390 | 9.912477 | 9.847913 | 10.152087 | 50 |
| 15 | 9.761285 | 9.912031 | 9.849254 | 10.150746 | 45 |
| 20 | 9.762177 | 9.911584 | 9.850593 | 10.149407 | 40 |
| 25 | 9.763067 | 9.911136 | 9.851931 | 10.148069 | 35 |
| 30 | 9.763954 | 9.910686 | 9.853268 | 10.146732 | 30 |
| 35 | 9.764838 | 9.910235 | 9.854603 | 10.145397 | 25 |
| 40 | 9.765720 | 9.909782 | 9.855938 | 10.144062 | 20 |
| 45 | 9.766598 | 9.909328 | 9.857270 | 10.142730 | 15 |
| 50 | 9.767475 | 9.908873 | 9.858602 | 10.141398 | 10 |
| 55 | 9.768348 | 9.908416 | 9.859932 | 10.140068 | 5 |
| 60 | 9.769219 | 9.007958 | 9.861261 | 10.138730 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | |

36.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.769219 | 9.907758 | 9.861251 | 10.138739 | 60 |
| 5 | 9.770087 | 9.907498 | 9.862589 | 10.137411 | 55 |
| 10 | 9.770952 | 9.907037 | 9.863915 | 10.136085 | 50 |
| 15 | 9.771815 | 9.906575 | 9.865240 | 10.134760 | 45 |
| 20 | 9.772675 | 9.906111 | 9.866564 | 10.133436 | 40 |
| 25 | 9.773533 | 9.905645 | 9.867887 | 10.132133 | 35 |
| 30 | 9.774388 | 9.905179 | 9.869209 | 10.130791 | 30 |
| 35 | 9.775240 | 9.904711 | 9.870529 | 10.129471 | 25 |
| 40 | 9.776090 | 9.904241 | 9.871849 | 10.128151 | 20 |
| 45 | 9.776937 | 9.903770 | 9.873167 | 10.126833 | 15 |
| 50 | 9.777781 | 9.903298 | 9.874484 | 10.125561 | 10 |
| 55 | 9.778624 | 9.902824 | 9.875800 | 10.124200 | 5 |
| 60 | 9.779463 | 9.902349 | 9.877114 | 10.122886 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

53.

37.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.779463 | 9.902349 | 9.877114 | 10.122886 | 60 |
| 5 | 9.780300 | 9.901872 | 9.878428 | 10.121572 | 55 |
| 10 | 9.781134 | 9.901394 | 9.879741 | 10.120259 | 50 |
| 15 | 9.781966 | 9.900914 | 9.881052 | 10.118948 | 45 |
| 20 | 9.782796 | 9.900433 | 9.882363 | 10.117637 | 40 |
| 25 | 9.783623 | 9.899951 | 9.883672 | 10.116328 | 35 |
| 30 | 9.784447 | 9.899467 | 9.884980 | 10.115020 | 30 |
| 35 | 9.785269 | 9.898981 | 9.886288 | 10.113712 | 25 |
| 40 | 9.786089 | 9.898494 | 9.887594 | 10.112406 | 20 |
| 45 | 9.786906 | 9.898006 | 9.888900 | 10.111100 | 15 |
| 50 | 9.787720 | 9.897516 | 9.890204 | 10.109796 | 10 |
| 55 | 9.788532 | 9.897025 | 9.891507 | 10.108493 | 5 |
| 60 | 9.789342 | 9.896530 | 9.892810 | 10.107190 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

52.

38.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.789342 | 9.896532 | 9.892810 | 10.107190 | 60 |
| 5 | 9.790149 | 9.896038 | 9.894111 | 10.105889 | 55 |
| 10 | 9.790954 | 9.895542 | 9.895412 | 10.104588 | 50 |
| 15 | 9.791757 | 9.895045 | 9.896712 | 10.103288 | 45 |
| 20 | 9.792557 | 9.894540 | 9.898010 | 10.101990 | 40 |
| 25 | 9.793354 | 9.894046 | 9.899308 | 10.100692 | 35 |
| 30 | 9.794150 | 9.893544 | 9.900605 | 10.099395 | 30 |
| 35 | 9.794942 | 9.893041 | 9.901901 | 10.098099 | 25 |
| 40 | 9.795733 | 9.892536 | 9.903197 | 10.096803 | 20 |
| 45 | 9.796521 | 9.892030 | 9 904491 | 10.095509 | 15 |
| 50 | 9.797307 | 9.891523 | 9.905785 | 10.094215 | 10 |
| 55 | 9.798091 | 9.891013 | 9.907077 | 10.092923 | 5 |
| 60 | 9.798872 | 9.890503 | 9.908369 | 10.091631 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

51.

39.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.798872 | 9.890503 | 9.908369 | 10.091631 | 60 |
| 5 | 9.799651 | 9.889990 | 9.909060 | 10.090340 | 55 |
| 10 | 9.800427 | 9.889477 | 9.910951 | 10.089049 | 50 |
| 15 | 9.801201 | 9.888961 | 9.912240 | 10.087760 | 45 |
| 20 | 9.801973 | 9.888444 | 9.913529 | 10.086471 | 40 |
| 25 | 9.802743 | 9.887926 | 9.914817 | 10.085183 | 35 |
| 30 | 9.803511 | 9.887406 | 9.916104 | 10.083895 | 30 |
| 35 | 9.804276 | 9.886885 | 9.917391 | 10.082609 | 25 |
| 40 | 9.805039 | 9.886362 | 9.918677 | 10.081321 | 20 |
| 45 | 9.805799 | 9.885837 | 9.919962 | 10.080038 | 15 |
| 50 | 9.806557 | 9.885311 | 9.921247 | 10.078753 | 10 |
| 55 | 9.807314 | 9.884783 | 9.922530 | 10.077470 | 5 |
| 60 | 9.808067 | 9.884254 | 9.923814 | 10.076186 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.808067 | 9.884254 | 9.923814 | 10.076186 | 60 |
| 5 | 9.808819 | 9.883723 | 9.925096 | 10.074904 | 55 |
| 10 | 9.809569 | 9.883191 | 9.926378 | 10.073622 | 50 |
| 15 | 9.810316 | 9.882657 | 9.927659 | 10.072341 | 45 |
| 20 | 9.811061 | 9.882121 | 9.928940 | 10.071060 | 40 |
| 25 | 9.811804 | 9.881584 | 9.930220 | 10.069780 | 35 |
| 30 | 9.812544 | 9.881046 | 9.931499 | 10.068501 | 30 |
| 35 | 9.813283 | 9.880505 | 9.932778 | 10.067222 | 25 |
| 40 | 9.814091 | 9.879963 | 9.934056 | 10.065944 | 20 |
| 45 | 9.814753 | 9.879420 | 9.935333 | 10.064667 | 15 |
| 50 | 9.815485 | 9.878875 | 9.936611 | 10.063389 | 10 |
| 55 | 9.816215 | 9.878328 | 9.937887 | 10.062113 | 5 |
| 60 | 9.816943 | 9.877780 | 9.939163 | 10.060837 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |



| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.816943 | 9.877780 | 9.939163 | 10.060837 | 60 |
| 5 | 9.817668 | 9.877230 | 9.940439 | 10.059561 | 55 |
| 10 | 9.818392 | 9.876678 | 9.941713 | 10.058287 | 50 |
| 15 | 9.819113 | 9.876125 | 9.942988 | 10.057012 | 45 |
| 20 | 9.819832 | 9.875571 | 9.944262 | 10.055738 | 40 |
| 25 | 9.820550 | 9.875014 | 9.945535 | 10.054465 | 35 |
| 30 | 9.821265 | 9.874456 | 9.946808 | 10.053192 | 30 |
| 35 | 9.821977 | 9.873896 | 9.948081 | 10.051919 | 25 |
| 40 | 9.822688 | 9.873335 | 9.949353 | 10.050647 | 20 |
| 45 | 9.823397 | 9.872772 | 9.950625 | 10.049375 | 15 |
| 50 | 9.824104 | 9.872208 | 9.951896 | 10.048104 | 10 |
| 55 | 9.824808 | 9.871641 | 9.953167 | 10.046833 | 5 |
| 60 | 9.825511 | 9.871073 | 9.954437 | 10.045563 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

42.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.825511 | 9.871073 | 9.954437 | 10.045503 | 60 |
| 5 | 9.826211 | 9.870504 | 9.955708 | 10.044292 | 55 |
| 10 | 9.826910 | 9.869933 | 9.956977 | 10.043023 | 50 |
| 15 | 9.827606 | 9.869360 | 9.958247 | 10.041753 | 45 |
| 20 | 9.828301 | 9.868785 | 9.959516 | 10.040484 | 40 |
| 25 | 9.828993 | 9.868209 | 9.960784 | 10.039216 | 35 |
| 30 | 9.829683 | 9.867631 | 9.962052 | 10.037948 | 30 |
| 35 | 9.830372 | 9.867051 | 9.963320 | 10.036680 | 25 |
| 40 | 9.831058 | 9.866470 | 9.964588 | 10.035412 | 20 |
| 45 | 9.831742 | 9.865887 | 9.965855 | 10.034145 | 15 |
| 50 | 9.832425 | 9.865302 | 9.967123 | 10.032877 | 10 |
| 55 | 9.833105 | 9.864716 | 9.968389 | 10.031611 | 5 |
| 60 | 9.833783 | 9.864127 | 9.969656 | 10.030344 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

47.

43.

| M | Sine. | Co-sine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.833783 | 9.864127 | 9.969656 | 10.030344 | 60 |
| 5 | 9.834460 | 9.863538 | 9.970922 | 10.029078 | 55 |
| 10 | 9.835134 | 9.862946 | 9.972188 | 10.027812 | 50 |
| 15 | 9.835807 | 9.862353 | 9.973454 | 10.026546 | 45 |
| 20 | 9.836377 | 9.861758 | 9.974720 | 10.025280 | 40 |
| 25 | 9.837146 | 9.861161 | 9.975985 | 10.024015 | 35 |
| 30 | 9.837812 | 9.860562 | 9.977250 | 10.022750 | 30 |
| 35 | 9.838477 | 9.859962 | 9.978515 | 10.021485 | 25 |
| 40 | 9.839140 | 9.859360 | 9.979780 | 10.020220 | 20 |
| 45 | 9.849800 | 9.858756 | 9.981044 | 10.018956 | 15 |
| 50 | 9.840459 | 9.858151 | 9.982309 | 10.017691 | 10 |
| 55 | 9.841116 | 9.857543 | 9.983573 | 10.016427 | 5 |
| 60 | 9.841771 | 9.856034 | 9.984837 | 10.015163 | 0 |
| | Co-sine. | Sine. | Co-tang. | Tangent. | M |

| M | Sine. | Co-ſine. | Tangent. | Co-tang. | |
|---|---|---|---|---|---|
| 0 | 9.841771 | 9.856934 | 9.984837 | 10.015163 | 60 |
| 5 | 9.842424 | 9.856323 | 9.986101 | 10.013899 | 55 |
| 10 | 9.843076 | 9.855711 | 9.987365 | 10.012635 | 50 |
| 15 | 9.843725 | 9.855096 | 9.988629 | 10.011371 | 45 |
| 20 | 9.844372 | 9.854480 | 9.989893 | 10.010107 | 40 |
| 25 | 9.845018 | 9.853862 | 9.991156 | 10.008844 | 35 |
| 30 | 9.845662 | 9.853242 | 9.992420 | 10.007580 | 30 |
| 35 | 9.846304 | 9.852620 | 9.993683 | 10.006317 | 25 |
| 40 | 9.846944 | 9.851997 | 9.994947 | 10.005053 | 20 |
| 45 | 9.847582 | 9.851372 | 9.996210 | 10.003790 | 15 |
| 50 | 9.848218 | 9.850745 | 9.997473 | 10.002527 | 10 |
| 55 | 9.848852 | 9.850116 | 9.998737 | 10.001263 | 5 |
| 60 | 9.849485 | 9.849485 | 10.000000 | 10.000000 | 0 |
| | Co-ſine. | Sine. | Co-tang. | Tangent. | M |

A

# TABLE

OF

# Logarithm Numbers.

## A Table of Logarithms.

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 1 | 0.000000 | 34 | 1.531479 | 67 | 1.826075 |
| 2 | 0.301030 | 35 | 1.544068 | 68 | 1.832509 |
| 3 | 0.477121 | 36 | 1.556303 | 69 | 1.838849 |
| 4 | 0.602060 | 37 | 1.568202 | 70 | 1.845098 |
| 5 | 0.698970 | 38 | 1.579783 | 71 | 1.851258 |
| 6 | 0.778151 | 39 | 1.591664 | 72 | 1.857332 |
| 7 | 0.845098 | 40 | 1.602060 | 73 | 1.863323 |
| 8 | 0.903090 | 41 | 1.612784 | 74 | 1.869232 |
| 9 | 0.954242 | 42 | 1.623249 | 75 | 1.875061 |
| 10 | 1.000000 | 43 | 1.633468 | 76 | 1.880813 |
| 11 | 1.041393 | 44 | 1.643452 | 77 | 1.886491 |
| 12 | 1.079181 | 45 | 1.653212 | 78 | 1.892094 |
| 13 | 1.113943 | 46 | 1.662758 | 79 | 1.897627 |
| 14 | 1.146128 | 47 | 1.672098 | 80 | 1.903090 |
| 15 | 1.176091 | 48 | 1.681241 | 81 | 1.908485 |
| 16 | 1.204124 | 49 | 1.690196 | 82 | 1.913814 |
| 17 | 1.230449 | 50 | 1.698970 | 83 | 1.919078 |
| 18 | 1.255272 | 51 | 1.707570 | 84 | 1.924279 |
| 19 | 1.278753 | 52 | 1.716003 | 85 | 1.929419 |
| 20 | 1.301230 | 53 | 1.724276 | 86 | 1.934498 |
| 21 | 1.322219 | 54 | 1.732394 | 87 | 1.939519 |
| 22 | 1.342422 | 55 | 1.740362 | 88 | 1.944482 |
| 23 | 1.361728 | 56 | 1.748188 | 89 | 1.949390 |
| 24 | 1.380211 | 57 | 1.755875 | 90 | 1.954242 |
| 25 | 1.397940 | 58 | 1.763428 | 91 | 1.959041 |
| 26 | 1.414973 | 59 | 1.770852 | 92 | 1.963788 |
| 27 | 1.431364 | 60 | 1.778151 | 93 | 1.968483 |
| 28 | 1.447158 | 61 | 1.785330 | 94 | 1.973128 |
| 29 | 1.462398 | 62 | 1.792391 | 95 | 1.977723 |
| 30 | 1.477121 | 63 | 1.799340 | 96 | 1.982271 |
| 31 | 1.491361 | 64 | 1.806180 | 97 | 1.980772 |
| 32 | 1.505150 | 65 | 1.812913 | 98 | 1.991226 |
| 33 | 1.518514 | 66 | 1.819544 | 99 | 1.995635 |
| 34 | 1.531479 | 67 | 1.826075 | 100 | 2.000000 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 101 | 2.004321 | 134 | 2.127105 | 167 | 2.222716 |
| 102 | 2.008600 | 135 | 2.130334 | 168 | 2.225309 |
| 103 | 2.012837 | 136 | 2.133539 | 169 | 2.227887 |
| 104 | 2.017033 | 137 | 2.136721 | 170 | 2.230449 |
| 105 | 2.021189 | 138 | 2.139879 | 171 | 2.232996 |
| 106 | 2.025306 | 139 | 2.143015 | 172 | 2.235528 |
| 107 | 2.029384 | 140 | 2.146128 | 173 | 2.238046 |
| 108 | 2.033424 | 141 | 2.149219 | 174 | 2.240549 |
| 109 | 2.037426 | 142 | 2.152288 | 175 | 2.243038 |
| 110 | 2.041393 | 143 | 2.155336 | 176 | 2.245513 |
| 111 | 2.045323 | 144 | 2.158362 | 177 | 2.247973 |
| 112 | 2.049218 | 145 | 2.161368 | 178 | 2.250420 |
| 113 | 2.053078 | 146 | 2.164353 | 179 | 2.252853 |
| 114 | 2.056905 | 147 | 2.167317 | 180 | 2.255273 |
| 115 | 2.060698 | 148 | 2.170262 | 181 | 2.257679 |
| 116 | 2.064458 | 149 | 2.173186 | 182 | 2.260071 |
| 117 | 2.068186 | 150 | 2.176091 | 183 | 2.262451 |
| 118 | 2.071882 | 151 | 2.178977 | 184 | 2.264818 |
| 119 | 2.075547 | 152 | 2.181844 | 185 | 2.267172 |
| 120 | 2.079181 | 153 | 2.184691 | 186 | 2.269513 |
| 121 | 2.082785 | 154 | 2.187521 | 187 | 2.271842 |
| 122 | 2.086359 | 155 | 2.190332 | 188 | 2.274158 |
| 123 | 2.089905 | 156 | 2.193125 | 189 | 2.276462 |
| 124 | 2.093422 | 157 | 2.195899 | 190 | 2.278754 |
| 125 | 2.096910 | 158 | 2.198657 | 191 | 2.281033 |
| 126 | 2.100371 | 159 | 2.201397 | 192 | 2.283301 |
| 127 | 2.103804 | 160 | 2.204110 | 193 | 2.285557 |
| 128 | 2.107209 | 161 | 2.206826 | 194 | 2.287802 |
| 129 | 2.110589 | 162 | 2.209515 | 195 | 2.290035 |
| 130 | 2.113943 | 163 | 2.212187 | 196 | 2.292256 |
| 131 | 2.117271 | 164 | 2.214844 | 197 | 2.294466 |
| 132 | 2.120574 | 165 | 2.217484 | 198 | 2.296665 |
| 133 | 2.123852 | 166 | 2.220108 | 199 | 2.298853 |
| 134 | 2.127105 | 167 | 2.222716 | 200 | 2.301029 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 201 | 2.303196 | 234 | 2.369216 | 267 | 2.426511 |
| 202 | 2.305351 | 235 | 2.371068 | 268 | 2.428135 |
| 203 | 2.307496 | 236 | 2.372912 | 269 | 2.429752 |
| 204 | 2.309630 | 237 | 2.374748 | 270 | 2.421364 |
| 205 | 2.311754 | 238 | 2.376577 | 271 | 2.432969 |
| 206 | 2.313867 | 239 | 2.378398 | 272 | 2.434569 |
| 207 | 2.315970 | 240 | 2.380211 | 273 | 2.436163 |
| 208 | 2.318063 | 241 | 2.382017 | 274 | 2.437751 |
| 209 | 2.320146 | 242 | 2.383815 | 275 | 2.439333 |
| 210 | 2.322219 | 243 | 2.385606 | 276 | 2.440909 |
| 211 | 2.324282 | 244 | 2.387389 | 277 | 2.442479 |
| 212 | 2.326336 | 245 | 2.389166 | 278 | 2.444045 |
| 213 | 2.328379 | 246 | 2.390935 | 279 | 2.445604 |
| 214 | 2.330414 | 247 | 2.392697 | 280 | 2.447158 |
| 215 | 2.332438 | 248 | 2.394452 | 281 | 2.448706 |
| 216 | 2.334454 | 249 | 2.396199 | 282 | 2.450249 |
| 217 | 2.336459 | 250 | 2.397940 | 283 | 2.451786 |
| 218 | 2.338456 | 251 | 2.399674 | 284 | 2.453318 |
| 219 | 2.340444 | 252 | 2.401401 | 285 | 2.454845 |
| 220 | 2.342422 | 253 | 2.403121 | 286 | 2.456366 |
| 221 | 2.344392 | 254 | 2.404834 | 287 | 2.457889 |
| 222 | 2.346353 | 255 | 2.406540 | 288 | 2.459392 |
| 223 | 2.348305 | 256 | 2.408239 | 289 | 2.460898 |
| 224 | 2.350248 | 257 | 2.409933 | 290 | 2.462398 |
| 225 | 2.352183 | 258 | 2.411619 | 291 | 2.463893 |
| 226 | 2.354108 | 259 | 2.413299 | 292 | 2.465383 |
| 227 | 2.356026 | 260 | 2.414973 | 293 | 2.466868 |
| 228 | 2.357935 | 261 | 2.416641 | 294 | 2.468347 |
| 229 | 2.359835 | 262 | 2.418301 | 295 | 2.469822 |
| 230 | 2.361728 | 263 | 2.419956 | 296 | 2.471292 |
| 231 | 2.363612 | 264 | 2.421604 | 297 | 2.472756 |
| 232 | 2.365488 | 265 | 2.423246 | 298 | 2.474216 |
| 233 | 2.367356 | 266 | 2.424882 | 299 | 2.475671 |
| 234 | 2.369216 | 267 | 2.426511 | 300 | 2.477121 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 301 | 2.478566 | 334 | 2.523746 | 367 | 2.564666 |
| 302 | 2.480007 | 335 | 2.525045 | 368 | 2.565848 |
| 303 | 2.481443 | 336 | 2.526339 | 369 | 2.567026 |
| 304 | 2.482877 | 337 | 2.527629 | 370 | 2.568202 |
| 305 | 2.484299 | 338 | 2.528916 | 371 | 2.569374 |
| 306 | 2.485721 | 339 | 2.530199 | 372 | 2.570543 |
| 307 | 2.487138 | 340 | 2.531479 | 373 | 2.571709 |
| 308 | 2.488551 | 341 | 2.532754 | 374 | 2.572872 |
| 309 | 2.489958 | 342 | 2.534026 | 375 | 2.574031 |
| 310 | 2.491362 | 343 | 2.535294 | 376 | 2.575188 |
| 311 | 2.492760 | 344 | 2.536558 | 377 | 2.576341 |
| 312 | 2.494155 | 345 | 2.537819 | 378 | 2.577492 |
| 313 | 2.495544 | 346 | 2.539076 | 379 | 2.578639 |
| 314 | 2.496929 | 347 | 2.540329 | 380 | 2.579784 |
| 315 | 2.498311 | 348 | 2.541579 | 381 | 2.580925 |
| 316 | 2.499687 | 349 | 2.542825 | 382 | 2.582063 |
| 317 | 2.501059 | 350 | 2.544008 | 383 | 2.583199 |
| 318 | 2.502427 | 351 | 2.545307 | 384 | 2.584331 |
| 319 | 2.503791 | 352 | 2.546543 | 385 | 2.585461 |
| 320 | 2.505149 | 353 | 2.547775 | 386 | 2.586587 |
| 321 | 2.506505 | 354 | 2.549003 | 387 | 2.587711 |
| 322 | 2.507856 | 355 | 2.550228 | 388 | 2.588832 |
| 323 | 2.509203 | 356 | 2.551449 | 389 | 2.589949 |
| 324 | 2.510545 | 357 | 2.552668 | 390 | 2.591065 |
| 325 | 2.511883 | 358 | 2.553883 | 391 | 2.592177 |
| 326 | 2.513218 | 359 | 2.555094 | 392 | 2.593286 |
| 327 | 2.514548 | 360 | 2.556303 | 393 | 2.394393 |
| 328 | 2.515874 | 361 | 2.557507 | 394 | 2.595496 |
| 329 | 2.517196 | 362 | 2.558709 | 395 | 2.596597 |
| 330 | 2.518514 | 363 | 2.559907 | 396 | 2.597695 |
| 331 | 2.519828 | 364 | 2.561101 | 397 | 2.598790 |
| 332 | 2.521138 | 365 | 2.562293 | 398 | 2.599883 |
| 333 | 2.522444 | 366 | 2.563481 | 399 | 2.600973 |
| 334 | 2.523746 | 367 | 2.564666 | 400 | 2.602059 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 401 | 2.603144 | 434 | 2.637489 | 467 | 2.669317 |
| 402 | 2.604226 | 435 | 2.638489 | 468 | 2.670246 |
| 403 | 2.605305 | 436 | 2.639486 | 469 | 2.671173 |
| 404 | 2.606381 | 437 | 2.640481 | 470 | 2.672098 |
| 405 | 2.607455 | 438 | 2.641475 | 471 | 2.673021 |
| 406 | 2.608526 | 439 | 2.642465 | 472 | 2.673942 |
| 407 | 2.609594 | 440 | 2.643453 | 473 | 2.674861 |
| 408 | 2.610660 | 441 | 2.644439 | 474 | 2.675778 |
| 409 | 2.611723 | 442 | 2.645422 | 475 | 2.676694 |
| 410 | 2.612784 | 443 | 2.646404 | 476 | 2.677607 |
| 411 | 2.613842 | 444 | 2.647383 | 477 | 2.678518 |
| 412 | 2.614897 | 445 | 2.648360 | 478 | 2.679428 |
| 413 | 2.615950 | 446 | 2.649335 | 479 | 2.680336 |
| 414 | 2.617000 | 447 | 2.650308 | 480 | 2.681241 |
| 415 | 2.618048 | 448 | 2.651278 | 481 | 2.682145 |
| 416 | 2.619093 | 449 | 2.652246 | 482 | 2.683047 |
| 417 | 2.620136 | 450 | 2.653213 | 483 | 2.683947 |
| 418 | 2.621176 | 451 | 2.654177 | 484 | 2.684845 |
| 419 | 2.622214 | 452 | 2.655138 | 485 | 2.685742 |
| 420 | 2.623249 | 453 | 2.656098 | 486 | 2.686636 |
| 421 | 2.624282 | 454 | 2.657056 | 487 | 2.687529 |
| 422 | 2.625312 | 455 | 2.658011 | 488 | 2.688419 |
| 423 | 2.626340 | 456 | 2.658965 | 489 | 2.689309 |
| 424 | 2.627366 | 457 | 2.659916 | 490 | 2.690196 |
| 425 | 2.628389 | 458 | 2.660865 | 491 | 2.691081 |
| 426 | 2.629409 | 459 | 2.661813 | 492 | 2.691965 |
| 427 | 2.630428 | 460 | 2.662758 | 493 | 2.692847 |
| 428 | 2.631444 | 461 | 2.663701 | 494 | 2.693727 |
| 429 | 2.632457 | 462 | 2.664642 | 495 | 2.694605 |
| 430 | 2.633468 | 463 | 2.665581 | 496 | 2.695482 |
| 431 | 2.634477 | 464 | 2.666518 | 497 | 2.696356 |
| 432 | 2.635484 | 465 | 2.667453 | 498 | 2.697229 |
| 433 | 2.636488 | 466 | 2.668386 | 499 | 2.698101 |
| 434 | 2.637489 | 467 | 2.669317 | 500 | 2.698970 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 501 | 2.699838 | 534 | 2.727541 | 567 | 2.753583 |
| 502 | 2.700704 | 535 | 2.728354 | 568 | 2.754348 |
| 503 | 2.701568 | 536 | 2.729165 | 569 | 2.755112 |
| 504 | 2.702430 | 537 | 2.729974 | 570 | 2.755875 |
| 505 | 2.703291 | 538 | 2.730782 | 571 | 2.756636 |
| 506 | 2.704151 | 539 | 2.731589 | 572 | 2.757396 |
| 507 | 2.705008 | 540 | 2.732394 | 573 | 2.758155 |
| 508 | 2.705863 | 541 | 2.733197 | 574 | 2.758912 |
| 509 | 2.706718 | 542 | 2.733999 | 575 | 2.759668 |
| 510 | 2.707570 | 543 | 2.734799 | 576 | 2.760422 |
| 511 | 2.708421 | 544 | 2.735599 | 577 | 2.761176 |
| 512 | 2.709269 | 545 | 2.736397 | 578 | 2.761928 |
| 513 | 2.710117 | 546 | 2.737192 | 579 | 2.762679 |
| 514 | 2.710963 | 547 | 2.737987 | 580 | 2.763428 |
| 515 | 2.711807 | 548 | 2.738781 | 581 | 2.764176 |
| 516 | 2.712649 | 549 | 2.739572 | 582 | 2.764923 |
| 517 | 2.713491 | 550 | 2.740363 | 583 | 2.765669 |
| 518 | 2.714329 | 551 | 2.741152 | 584 | 2.766413 |
| 519 | 2.715167 | 552 | 2.741939 | 585 | 2.767156 |
| 520 | 2.716003 | 553 | 2.742725 | 586 | 2.767898 |
| 521 | 2.716838 | 554 | 2.743509 | 587 | 2.768638 |
| 522 | 2.717671 | 555 | 2.744293 | 588 | 2.769377 |
| 523 | 2.718502 | 556 | 2.745075 | 589 | 2.770115 |
| 524 | 2.719331 | 557 | 2.745855 | 590 | 2.770852 |
| 525 | 2.720159 | 558 | 2.746634 | 591 | 2.771587 |
| 526 | 2.720986 | 559 | 2.747412 | 592 | 2.772322 |
| 527 | 2.721811 | 560 | 2.748188 | 593 | 2.773055 |
| 528 | 2.722634 | 561 | 2.748963 | 594 | 2.773786 |
| 529 | 2.723456 | 562 | 2.749736 | 595 | 2.774517 |
| 530 | 2.724276 | 563 | 2.750508 | 596 | 2.775246 |
| 531 | 2.725095 | 564 | 2.751279 | 597 | 2.775974 |
| 532 | 2.725912 | 565 | 2.752048 | 598 | 2.776701 |
| 533 | 2.726727 | 566 | 2.752816 | 599 | 2.777427 |
| 534 | 2.727541 | 567 | 2.753583 | 600 | 2.778151 |

| N. | Logarith. | N. | Logarith | N. | Logarith |
|---|---|---|---|---|---|
| 601 | 2.778874 | 634 | 2.802089 | 667 | 2.824126 |
| 602 | 2.779596 | 635 | 2.802774 | 668 | 2.824776 |
| 603 | 2.780317 | 636 | 2.803457 | 699 | 2.825426 |
| 604 | 2.781037 | 637 | 2.804139 | 670 | 2.826075 |
| 605 | 2.781755 | 638 | 2.804821 | 671 | 2.826724 |
| 606 | 2.782473 | 639 | 2.805501 | 672 | 2.827369 |
| 607 | 2.783189 | 640 | 2.806179 | 673 | 2.828015 |
| 608 | 2.783904 | 641 | 2.806858 | 674 | 2.828659 |
| 609 | 2.784617 | 642 | 2.807535 | 675 | 2.829304 |
| 610 | 2.785329 | 643 | 2.808211 | 676 | 2.829947 |
| 611 | 2.786041 | 644 | 2.808886 | 677 | 2.830589 |
| 612 | 2.786751 | 645 | 2.809559 | 678 | 2.831229 |
| 613 | 2.787460 | 646 | 2.810233 | 679 | 2.831869 |
| 614 | 2.788164 | 647 | 2.810904 | 680 | 2.232509 |
| 615 | 2.788875 | 648 | 2.811575 | 681 | 2.833147 |
| 616 | 2.789581 | 649 | 2.812245 | 682 | 2.833784 |
| 617 | 2.790285 | 650 | 2.812913 | 683 | 2.834421 |
| 618 | 2.790988 | 651 | 2.813581 | 684 | 2.835056 |
| 619 | 2.791691 | 652 | 2.814248 | 685 | 2.835691 |
| 620 | 2.792302 | 653 | 2.814913 | 686 | 2.836324 |
| 621 | 2.793092 | 654 | 2.815578 | 687 | 2.836957 |
| 622 | 2.793791 | 655 | 2.816241 | 688 | 2.837588 |
| 623 | 2.794488 | 656 | 2.816904 | 689 | 2.838219 |
| 624 | 2.795185 | 657 | 2.817565 | 690 | 2.838849 |
| 625 | 2.795880 | 658 | 2.818226 | 691 | 2.839478 |
| 626 | 2.796574 | 659 | 2.818885 | 692 | 2.840106 |
| 627 | 2.797268 | 660 | 2.819543 | 693 | 2.840733 |
| 628 | 2.797959 | 661 | 2.820201 | 694 | 2.841359 |
| 629 | 2.798651 | 662 | 2.820858 | 695 | 2.841985 |
| 630 | 2.799341 | 663 | 2.821514 | 696 | 2.842609 |
| 631 | 2.800029 | 664 | 2.822168 | 697 | 2.843233 |
| 632 | 2.800717 | 665 | 2.822822 | 698 | 2.843855 |
| 633 | 2.801404 | 666 | 2.823474 | 699 | 2.844477 |
| 644 | 2.802089 | 667 | 2.824126 | 700 | 2.845098 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 701 | 2.845718 | 734 | 2.865696 | 767 | 2.884794 |
| 702 | 2.846337 | 735 | 2.866287 | 768 | 2.885361 |
| 703 | 2.846955 | 736 | 2.866878 | 769 | 2.885926 |
| 704 | 2.847573 | 737 | 2.867467 | 770 | 2.886491 |
| 705 | 2.848189 | 738 | 2.868056 | 771 | 2.887054 |
| 706 | 2.848805 | 739 | 2.868643 | 772 | 2.887617 |
| 707 | 2.849419 | 740 | 2.869232 | 773 | 2.888179 |
| 708 | 2.850033 | 741 | 2.869818 | 774 | 2.888741 |
| 709 | 2.850646 | 742 | 2.870404 | 775 | 2.889302 |
| 710 | 2.851258 | 743 | 2.870989 | 776 | 2.889862 |
| 711 | 2.851869 | 744 | 2.871573 | 777 | 2.890421 |
| 712 | 2.852479 | 745 | 2.872156 | 778 | 2.890979 |
| 713 | 2.853089 | 746 | 2.872739 | 779 | 2.891537 |
| 714 | 2.853698 | 747 | 2.873321 | 780 | 2.892095 |
| 715 | 2.854306 | 748 | 2.873902 | 781 | 2.892651 |
| 716 | 2.854913 | 749 | 2.874482 | 782 | 2.893207 |
| 717 | 2.855519 | 750 | 2.875061 | 783 | 2.893762 |
| 718 | 2.856124 | 751 | 2.875639 | 784 | 2.894316 |
| 719 | 2.856729 | 752 | 2.876218 | 785 | 2.894869 |
| 720 | 2.857332 | 753 | 2.876795 | 786 | 2.895423 |
| 721 | 2.857935 | 754 | 2.877371 | 787 | 2.895975 |
| 722 | 2.858537 | 755 | 2.877947 | 788 | 2.896526 |
| 723 | 2.859138 | 756 | 2.878522 | 789 | 2.897077 |
| 724 | 2.859739 | 757 | 2.879096 | 790 | 2.897677 |
| 725 | 2.860338 | 758 | 2.879669 | 791 | 2.898176 |
| 726 | 2.860937 | 759 | 2.880242 | 792 | 2.898725 |
| 727 | 2.861534 | 760 | 2.880814 | 793 | 2.899273 |
| 728 | 2.862131 | 761 | 2.881385 | 794 | 2.899821 |
| 729 | 2.862728 | 762 | 2.881955 | 795 | 2.900367 |
| 730 | 2.863323 | 763 | 2.882525 | 796 | 2.900913 |
| 731 | 2.863917 | 764 | 2.883093 | 797 | 2.901458 |
| 732 | 2.864511 | 765 | 2.883661 | 798 | 2.902003 |
| 733 | 2.865104 | 766 | 2.884229 | 799 | 2.902547 |
| 734 | 2.865696 | 767 | 2.884795 | 800 | 2.903089 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 801 | 2.903633 | 834 | 2.921166 | 867 | 2.938019 |
| 802 | 2.904174 | 835 | 2.921686 | 868 | 2.938519 |
| 803 | 2.904716 | 836 | 2.922206 | 869 | 2.939019 |
| 804 | 2.905256 | 837 | 2.922725 | 870 | 2.939519 |
| 805 | 2.905796 | 838 | 2.923244 | 871 | 2.940018 |
| 806 | 2.906335 | 839 | 2.923762 | 872 | 2.940516 |
| 807 | 2.906874 | 840 | 2.924279 | 873 | 2.941014 |
| 808 | 2.907411 | 841 | 2.924796 | 874 | 2.941511 |
| 809 | 2.907949 | 842 | 2.925312 | 875 | 2.942008 |
| 810 | 2.908485 | 843 | 2.925828 | 876 | 2.942504 |
| 811 | 2.909021 | 844 | 2.926342 | 877 | 2.942999 |
| 812 | 2.909556 | 845 | 2.926857 | 878 | 2.943495 |
| 813 | 2.910091 | 846 | 2.927370 | 879 | 2.943989 |
| 814 | 2.910624 | 847 | 2.927883 | 880 | 2.944483 |
| 815 | 2.911158 | 848 | 2.928396 | 881 | 2.944976 |
| 816 | 2.911690 | 849 | 2.928908 | 882 | 2.945468 |
| 817 | 2.912222 | 850 | 2.929419 | 883 | 2.945961 |
| 818 | 2.912753 | 851 | 2.929929 | 884 | 2.946452 |
| 819 | 2.913284 | 852 | 2.930439 | 885 | 2.946943 |
| 820 | 2.913814 | 853 | 2.930949 | 886 | 2.947434 |
| 821 | 2.914343 | 854 | 2.931458 | 887 | 2.947924 |
| 822 | 2.914872 | 855 | 2.931966 | 888 | 2.948413 |
| 823 | 2.915399 | 856 | 2.932474 | 889 | 2.948902 |
| 824 | 2.915927 | 857 | 2.932981 | 890 | 2.949390 |
| 825 | 2.916454 | 858 | 2.933487 | 891 | 2.940878 |
| 826 | 2.916980 | 859 | 2.933993 | 892 | 2.950365 |
| 827 | 2.917506 | 860 | 2.934498 | 893 | 2.950851 |
| 828 | 2.918030 | 861 | 2.935003 | 894 | 2.951338 |
| 829 | 2.918555 | 862 | 2.935507 | 895 | 2.951823 |
| 830 | 2.919078 | 863 | 2.936011 | 896 | 2.952308 |
| 831 | 2.919601 | 864 | 2.936514 | 897 | 2.952792 |
| 832 | 2.929123 | 865 | 2.937016 | 898 | 2.953276 |
| 833 | 2.920645 | 866 | 2.937518 | 899 | 2.953759 |
| 834 | 2.921166 | 867 | 2.638019 | 900 | 2.954243 |

| N. | Logarith. | N. | Logarith. | N. | Logarith. |
|---|---|---|---|---|---|
| 901 | 2.954725 | 934 | 2.970347 | 967 | 2.985426 |
| 902 | 2.955207 | 935 | 2.970812 | 968 | 2.985875 |
| 903 | 2.955688 | 936 | 2.971276 | 969 | 2.986324 |
| 904 | 2.956198 | 937 | 2.971739 | 970 | 2.986772 |
| 905 | 2.956649 | 938 | 2.972203 | 971 | 2.987219 |
| 906 | 2.957128 | 939 | 2.972669 | 972 | 2.987666 |
| 907 | 2.957607 | 940 | 2.973128 | 973 | 2.988113 |
| 908 | 2.958086 | 941 | 2.973589 | 974 | 2.988559 |
| 909 | 2.958564 | 942 | 2.974050 | 975 | 2.989005 |
| 910 | 2.959041 | 943 | 2.974512 | 976 | 2.989449 |
| 911 | 2.959518 | 944 | 2.974972 | 977 | 2.989895 |
| 912 | 2.959995 | 945 | 2.975432 | 978 | 2.990339 |
| 913 | 2.960471 | 946 | 2.975891 | 979 | 2.990783 |
| 914 | 2.960946 | 947 | 2.976349 | 980 | 2.991226 |
| 915 | 2.961421 | 948 | 2.976808 | 981 | 2.991669 |
| 916 | 2.961895 | 949 | 2.977266 | 982 | 2.992111 |
| 917 | 2.962369 | 950 | 2.977724 | 983 | 2.992554 |
| 918 | 2.962843 | 951 | 2.978181 | 984 | 2.992995 |
| 919 | 2.963315 | 952 | 2.978637 | 985 | 2.993436 |
| 920 | 2.963788 | 953 | 2.979093 | 986 | 2.993877 |
| 921 | 2.964259 | 954 | 2.979548 | 987 | 2.994317 |
| 922 | 2.964731 | 955 | 2.980003 | 988 | 2.994756 |
| 923 | 2.965202 | 956 | 2.980458 | 989 | 2.995196 |
| 924 | 2.965672 | 957 | 2.980912 | 990 | 2.995635 |
| 925 | 2.966142 | 958 | 2.981366 | 991 | 2.996074 |
| 926 | 2.966611 | 959 | 2.981819 | 992 | 2.996512 |
| 927 | 2.967079 | 960 | 2.982271 | 993 | 2.996949 |
| 928 | 2.967548 | 961 | 2.982723 | 994 | 2.997386 |
| 929 | 2.968016 | 962 | 2.983175 | 995 | 2.997823 |
| 930 | 2.968483 | 963 | 2.983626 | 996 | 2.998250 |
| 931 | 2.968949 | 964 | 2.984077 | 997 | 2.998695 |
| 932 | 2.969416 | 965 | 2.984527 | 998 | 2.999130 |
| 933 | 2.969882 | 966 | 2.984977 | 999 | 2.999560 |
| 934 | 2.970347 | 967 | 2.985426 | 1000 | 3.000000 |

THE uſe of theſe TABLES hath been already at large ſhewed in the firſt and twelfth chapters; therefore I ſhall ſay no more of them here.

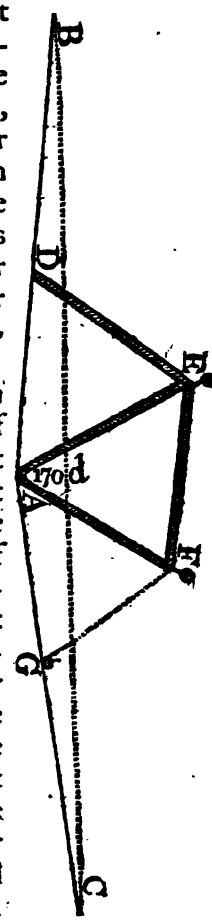
# AN APPENDIX,

SHEWING FARTHER

## How to ſurvey by the Chain only: with an uſeful Table to that Purpoſe.

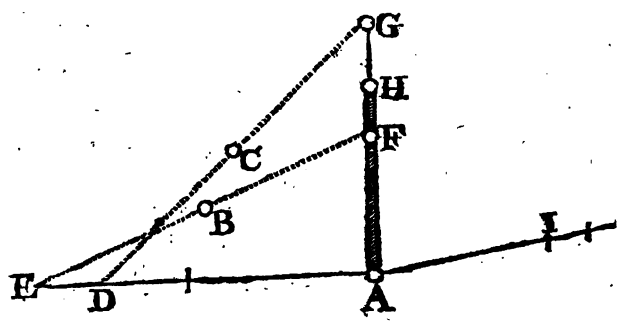
HAVING, in the ſixth chapter of the foregoing Treatiſe, ſhewn a ready and eaſy way for taking the quantity of an angle in the field by the chain only, and underſtanding it has been approved of by ſurveyors and others, I think it not improper to ſay ſomething more upon that ſubject in this place. And that this way of working may be practiſed with as much eaſe as by uſing the moſt coſtly inſtruments, there are two ſeeming difficulties muſt be removed. The firſt is, when the angle becomes very obtuſe, or contains 170 degrees or more, then the ſubtending or chord-line will hardly be diſtinguiſhable between five or ſix degrees, there being but $\frac{1}{3}$ part of a link difference between 170 degrees and 171 degrees, and not above $\frac{1}{10}$ part between 178 and 179 degrees. To remedy which, you need not take the quantity of that angle at all, eſpecially if it be an inward angle, but meaſure directly from B to C; and when you come right againſt A, take an off-ſet (which

you may do with a rod or line only, as true as with a croſs or other inſtrument) this off-ſet being put down in your field-book, will do the buſineſs when you come to protract, as well as if you had taken the angle in the field: but if that is not ſufficient, or any other reaſon neceſſitate you to take the angle A, there place a ſtrong ſtick in the angular point A, and putting the ring of the chain over it, ſtretch it out at full length, both in the line AB and AC; and where the end of the chain falls, there place ſticks alſo, as at D and G. Remove your chain from A, and put the ring over the ſtick at D, and ſtretch it out towards E. Now you ſhould have another chain, or a ſmall line, (which you may carry in your pocket) exactly of the length of a chain, with a loop at each end: which put over the ſtick at A, and taking the other loop of the line in one hand, and the looſe end of the chain in the other hand, go backward till both being ſtretched ſtrait meet at E, then will DAE be an equilateral triangle, to which add another equilateral triangle by looſing the chain at D, and putting it over the ſtick at E, letting the line remain as it was faſtened at A, and taking the looſe ends again of the chain and line in your hands, go backwards as before, till both being ſtretched ſtrait, meet in F. So have you formed two equilateral triangles, and DAF will contain 120 degrees. Laſtly, with your chain meaſure the neareſt diſtance FG, which ſuppoſe to be 84 links and a half; which ſum look for in the following table, and right againſt it you will find



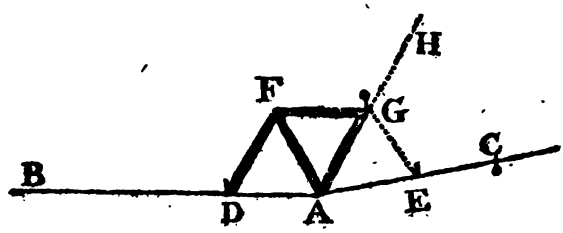

59

50 degrees, which added to 120, make 170 degrees, the quantity of the angle ſought; or if you have not a mind to uſe the table, you may note it down in your field-book, thus, Δ Δ $84\frac{1}{2}$, ſignifying that angle conſiſts of 120 degrees and $84\frac{1}{2}$ links for its ſubtending line; and you may plot it, by performing with your compaſſes upon the paper, what you did in the field with the chain. But to take the quantity of an obtuſe angle with a ſingle chain only, let EAI, in the following figure, be an angle of about 170 degrees; meaſure from A towards B and C, half a chain on each ſide, as to D and E, where ſtick down ſticks, and one at A; then put the ring at one end of the chain over the ſtick at A, and the other end over the ſtick at D, and taking the chain in the middle by the ring that is commonly at the end of 50 links, go backwards till both parts are ſtrait, and there ſtick down a ſtick; as at F. Then looſe the ring from D, and put it over the ſtick at F, and taking the very middle of the chain, make both parts ſtrait, which they will be at C, where ſtick down a ſtick, from which meaſure to E, noting it down in your Field-Book, Δ Δ $42\frac{1}{2}$; and when you plot it, remember to make the ſides of your equilateral triangles but of 50 links each, for in this caſe you cannot have recourſe to the following TABLE,




that being made to the radius of 100 links, unleſs you double the number of links found between C and E; or which is better, when you have finiſhed your two equi-

lateral triangles, one end of the chain hanging at A, ſtretch the other at full length over the ſtick at G, which will fall at H; then meaſuring the neareſt diſtance between H and C, you will find it to be 84½ links, againſt which in the table ſtand 50 degrees, which added to the angle DAG 120 degrees, make 170 degrees for the angle BAC. [*See this figure.*]



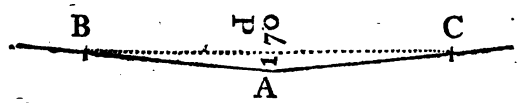

But if you had rather meaſure this angle, by firſt taking out a right one from it, proceed thus: [*See the figure on the other ſide.*] put one ring of your chain over the ſtick at the angular point A, and ſtretching out the chain, let the other end fall any where at pleaſure, as at B or C; where ſtick a ſtick through the ring, and looſing that end at A; take it in your hand, and ſtretching it ſtrait, ſee in what part it will juſt touch the hedge AE; which will be at D, if the other end be at C; or at E, if the other end be at B; and there make a mark; which done, keeping the end of your chain in your hand, go backward from B or C, towards G or F, till your chain is ſtrait; then moving yourſelf ſideways to and fro, till you perceive your chain to lie in a ſtrait line with BE or CD, at the end of it place a ſtick at F or G, from whence to A will be a line perpendicular to AE; wherefore from A ſet off one chain in that line, which will fall at H; and one chain upon the line AI, which falls at I, and meaſuring the diſtance HI, you will find it 128 links $\frac{5}{10}$ parts of a link, or 80 degrees; which added to the right angle, makes 170 degrees, which was the angle required.

Otherwiſe you may form a right angle, by fixing one end of the chain in the angular point, and the other end at

at 40 links diſtance in the hedge; then take 50 links in one hand, and 30 in the other, and ſtretch both parts ſtrait, their meeting will conſtitute a right angle, it being well known that three lines in the proportion of 3, 4, and 5, will form a right-angled triangle.

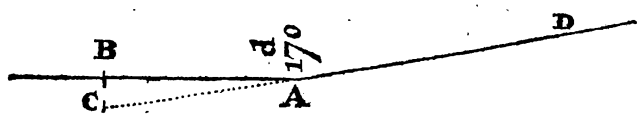
Several other ways might be ſhewn to take a right angle in the field by the chain only, and alſo to meaſure the quantity of an obtuſe angle; but omitting thoſe, I ſhall only mention one way more, to take the quantity of an obtuſe angle, which is as follows.

Let A be the angle required to be taken in the field; by the chain firſt from A, ſet off two chains, one to B, the other to C: then fixing one end of the chain in B, ſtretch the other directly in a ſtrait line towards C, making a mark where the end falls, as at 7; meaſure the diſtance from 7 to A, which ſuppoſe 8 links $\frac{7}{10}$ parts of a link; look in the following TABLE for this number, and right againſt it, you will find 5 degrees; which dou-




bled (the angles A C 7 and A B 7 being equal, becauſe the ſides A B and A C are equal) makes 10 degrees; and ſubtracted from 180, leaves 170 for the angle at A required.

If the angle be an outward one, continue one of the lines, as D A to C, making A C one chain; alſo ſet off one chain upon the other line from A to B; then meaſure the diſtance B C, which ſuppoſe to be 17 links $\frac{1}{10}$ parts




of a link, and anſwers in the table to 10 degrees, which is the complement of the angle A to 180 degrees; therefore take 10 from 180, remains 170 for the outward angle D A B.

Theſe examples, I apprehend, will remove the difficulty of meaſuring obtuſe angles, and make the matter both plain and eaſy; as for acute angles, and ſuch obtuſe ones as do not much exceed 90 degrees, you have the way to meaſure them already in the ſixth chapter of the foregoing treatiſe, with ſundry ways to meaſure a field with the chain only, to which I refer you.

It remains now to ſpeak of the ſecond ſeeming difficulty, which lies in the trouble of plotting after this way: to remove which you may have a protractor made with links on it inſtead of degrees, or both, if you pleaſe; which the inſtrument-maker may ſoon do by the help of this table. Or you may very well uſe the common protractors; for having a copy of this table in the field with you, you may at once note down the degrees of every angle, without mentioning the ſubtendents; or if you only note down the ſubtendents in your field-book when you come home, you may at once take all the angles in degrees anſwerable to them, and ſo plot with an ordinary protractor, as at other times. I have extended the table only to 140 degrees; for when an angle exceeds that number, your beſt way of meaſuring it, is by the method juſt now taught.

What has been already ſaid, I preſume, will ſufficiently explain the following table, and the uſe thereof, therefore ſhall not trouble you with repetitions; only deſire you to remember, that the table is made for the radius of one chain, or 100 links; and the ſubtendents, or chord lines, are in links, and decimal parts of a link: ſo that when you would uſe this table, you muſt ſet off but one chain from the angle (you deſire to know the quantity of) on either hedge, and meaſuring the neareſt diſtance between the two ends of the chains, a-croſs from hedge to hedge, look for the number of links in the table that neareſt diſtance contains, and right againſt it you will find the quantity of the angle as true, as if taken by the beſt Semicircle, Circumferentor or Theodolite.

EXAMPLE.

## EXAMPLE.

I would know the quantity in degrees of an angle whoſe ſubtendent is (accounting one chain radius) 80 links: accordingly I look for 80 links in the table, and the neareſt number to it is 79 links $\frac{7}{10}$ parts of a link, and right againſt it ſtands 47 degrees; wherefore I ſay, that angle conſiſts of 47 degrees and ſomething more; and if you deſire to know how much the remaining $\frac{3}{10}$ is, you may ſee by the table, that in an angle of this magnitude, one link and a half anſwers to a degree; ſo that $\frac{3}{10}$ parts of a link is juſt 12 minutes. The exact angle therefore is 47° 12′.

What has been ſaid concerning meaſuring a field, or taking an angle by the chain only, either in the Appendix, or 6th chapter, may as well be applied to a pole or ſtrait rod divided into 100 equal parts; every diviſion of the rod anſwering to a link of the chain: and the table ſerves as well for a rod ſo divided as the chain; only obſerve in meaſuring the length of the links, to call every 4 poles 1 chain, and every 4 diviſions of the pole 1 link; then you may caſt it up as if it had been meaſured by the chain. You may provide a rod made to ſhoot one part into another like a fiſhing-rod, to be uſed as a cane, in the head whereof place a ſmall compaſs; and this inſtrument will be ſufficient to ſurvey any piece of ground with, without a horſe-load of braſs ſemicircles, heavy ball-ſockets, wooden tables and frames, and three-legged ſtaffs, &c. which only ſerve to amuſe the ignorant countryman, and make him more freely pay the ſurveyor.

*The* TABLE *of Chords, or Subtendents to the Radius of one Chain of* Gunter's *or* 100 *Links.*

| Degrees. | Links. | Tenths of a Link. | Degrees. | Links. | Tenths of a Link. | Degrees. | Links. | Tenths of a Link. | Degrees. | Links. | Tenths of a Link. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 7 | 36 | 61 | 8 | 71 | 116 | 1 | 106 | 159 | 7 |
| 2 | 3 | 5 | 37 | 63 | 4 | 72 | 117 | 5 | 107 | 160 | 8 |
| 3 | 5 | 2 | 38 | 65 | 1 | 73 | 119 | 0 | 108 | 161 | 8 |
| 4 | 7 | 0 | 39 | 66 | 8 | 74 | 120 | 4 | 109 | 162 | 8 |
| 5 | 8 | 7 | 40 | 68 | 4 | 75 | 121 | 8 | 110 | 163 | 8 |
| 6 | 10 | 5 | 41 | 70 | 0 | 76 | 123 | 1 | 111 | 164 | 8 |
| 7 | 12 | 2 | 42 | 71 | 7 | 77 | 124 | 5 | 112 | 165 | 8 |
| 8 | 14 | 0 | 43 | 73 | 3 | 78 | 125 | 9 | 113 | 166 | 8 |
| 9 | 15 | 7 | 44 | 74 | 9 | 79 | 127 | 2 | 114 | 167 | 7 |
| 10 | 17 | 4 | 45 | 76 | 5 | 80 | 128 | 5 | 115 | 168 | 7 |
| 11 | 19 | 2 | 46 | 78 | 2 | 81 | 129 | 9 | 116 | 169 | 6 |
| 12 | 20 | 9 | 47 | 79 | 7 | 82 | 131 | 2 | 117 | 170 | 5 |
| 13 | 22 | 6 | 48 | 81 | 3 | 83 | 132 | 5 | 118 | 171 | 4 |
| 14 | 24 | 4 | 49 | 82 | 9 | 84 | 133 | 8 | 119 | 172 | 3 |
| 15 | 26 | 1 | 50 | 84 | 5 | 85 | 135 | 1 | 120 | 173 | 2 |
| 16 | 27 | 8 | 51 | 86 | 1 | 86 | 136 | 4 | 121 | 174 | 1 |
| 17 | 29 | 6 | 52 | 87 | 7 | 87 | 137 | 7 | 122 | 174 | 9 |
| 18 | 31 | 3 | 53 | 89 | 2 | 88 | 139 | 0 | 123 | 175 | 7 |
| 19 | 33 | 0 | 54 | 90 | 8 | 89 | 140 | 2 | 124 | 176 | 6 |
| 20 | 34 | 7 | 55 | 92 | 3 | 90 | 141 | 4 | 125 | 177 | 4 |
| 21 | 36 | 4 | 56 | 93 | 9 | 91 | 142 | 6 | 126 | 178 | 2 |
| 22 | 38 | 2 | 57 | 95 | 4 | 92 | 143 | 8 | 127 | 179 | 0 |
| 23 | 39 | 9 | 58 | 97 | 0 | 93 | 145 | 0 | 128 | 179 | 8 |
| 24 | 41 | 6 | 59 | 98 | 5 | 94 | 146 | 2 | 129 | 180 | 5 |
| 25 | 43 | 3 | 60 | 100 | 0 | 95 | 147 | 4 | 130 | 181 | 3 |
| 26 | 44 | 9 | 61 | 101 | 5 | 96 | 148 | 6 | 131 | 182 | 0 |
| 27 | 46 | 7 | 62 | 103 | 0 | 97 | 149 | 8 | 132 | 182 | 7 |
| 28 | 48 | 4 | 63 | 104 | 5 | 98 | 151 | 0 | 133 | 183 | 4 |
| 29 | 50 | 1 | 64 | 106 | 0 | 99 | 152 | 1 | 134 | 184 | 0 |
| 30 | 51 | 8 | 65 | 107 | 4 | 100 | 153 | 2 | 135 | 184 | 7 |
| 31 | 53 | 4 | 66 | 108 | 9 | 101 | 154 | 3 | 136 | 185 | 4 |
| 32 | 55 | 1 | 67 | 110 | 4 | 102 | 155 | 4 | 137 | 186 | 1 |
| 33 | 56 | 8 | 68 | 111 | 8 | 103 | 156 | 5 | 138 | 186 | 7 |
| 34 | 58 | 5 | 69 | 113 | 3 | 104 | 157 | 6 | 139 | 187 | 3 |
| 35 | 60 | 1 | 70 | 114 | 7 | 105 | 158 | 7 | 140 | 187 | 9 |

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